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John F. Dashiell was Consulting Editor of this series from its inception in 1931 until January 1, 1950.

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PERSONNEL AND INDUSTRIAL PSYCHOLOGY

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To

L. H. G.

and

E. A. B.

PREFACE

National emergencies, such as the recent war, create numerous problems relative to the classification and placement of workers, their training and morale, and the methods and procedures of work through which they become effective producers. It is unfortunate but true that advancement in the development and use of scientific personnel and industrial methods is greatest under such abnormal conditions. At these times attention is focused upon methodology in order to achieve rapid solutions to the urgent problems of production and transportation. After the emergency has passed some of the newer scientific procedures are continued in force with the result that business, industry, and labor employ to a greater extent sounder procedures in dealing with human problems. Thus it is said, and perhaps with some justification, that it was fortunate that the United States suffered a severe economic depression only a relatively few years before it was drawn into the recent armed conflict, because the measures adopted as a result of this emergency placed the country in a better position to deal with the personnel and industrial problems arising as a consequence of the war.

While the rate at which scientific employment methods are adopted is, in the minds of many industrial psychologists, so slow as to cause despair, it nevertheless is true that if a long-term view is taken significant increments will be revealed. It is difficult to measure exactly and in quantitative terms the trends toward the use of scientifically developed personnel procedures. However, some surveys have been conducted which have shown increasing application of such procedures, *e.g.*, the increased use of psychological tests in selection. But more than this, some psychologists who have worked with business, industry, and labor have discerned through the years an increasing interest in a genuinely professional approach to the problems. Certainly if university teaching has had any effect whatsoever upon its students the thousands who have been exposed to courses in industrial psychology and personnel methods must have carried away with them some understanding of the usefulness of psychological methods and findings which later has contributed to their thinking about the personnel problems with which they have been confronted.

In writing this book the authors have, of course, emphasized the need of using scientific methods and procedures. The choice of topics discussed no doubt is biased by the kinds of specific experiences that they have had in working with personnel problems in business and industry, but the endeavor has been to sample all the major fields that currently demand further study. The reader will find that certain approaches and emphases have broken from the traditional, and attempts have been made to reorient the thinking and analysis in terms of what appear to the authors to be the primary problems of the future. There is no doubt but that the development of many topics in the book is greatly influenced by the problems that have been met throughout the years in the teaching of courses in personnel and industrial psychology at the University.

It is the authors' hope that this book will meet the needs both of university students and of those in business, industry, and labor, who desire to obtain a foundation in the basic principles involved in the application of scientific psychology to problems of the worker. The extent to which this hope will be realized will, in part at least, be a function of the degree to which the reader will be willing in the beginning to consider basic underlying principles before seeking solutions to his immediate problems.

It is difficult to acknowledge in any satisfactory manner the aid the authors received from others in the preparation of this book. Specific recognition and thanks are given to W. W. Norton & Company for permission to quote from M. S. Viteles' classic "Industrial Psychology"; to the Williams & Wilkins Company for quotations from W. W. Charters and I. B. Whitley, "Analysis of Secretarial Duties and Traits;" to the American Book Company for permission to quote from W. H. Stead, C. L. Shartle, *et al.*, "Occupational Counseling Techniques"; and to the U. S. Army Air Forces, Office of the Surgeon, for permission to quote from M. P. Crawford, R. T. Sollenberger, L. B. Ward, C. W. Brown, and E. E. Ghiselli, "Psychological Research on Operational Training in the Continental Air Forces," AAF Aviation Psychology Program Research Reports, No. 16, and to use certain material collected in that research program. Appreciation is acknowledged for the assistance rendered by the many students at the University of California who critically evaluated the book in its four earlier mimeographed editions used as a text in the course in Personnel and Industrial Psychology. The authors are indebted to

their academic colleagues and to associates in business, industry, and labor, who because of their number go unmentioned individually, but from whom many ideas have been obtained. Finally the authors wish to acknowledge the generous assistance rendered by their wives, to whom this book is gratefully dedicated.

EDWIN E. GHISELLI
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CHAPTER I

THE SCIENTIFIC STUDY OF HUMAN FACTORS IN INDUSTRIAL PROBLEMS

To say that human problems in industrial development have received no consideration would be a gross misstatement of fact. Throughout the past century there has been an increasing amount of exploration, investigation, and discussion of the role played by the worker in industry. To affirm, however, that these endeavors have resulted in a maximum exploitation of the mutual productive power possessed by management and labor would be far from the truth.

To be sure, most workers no longer are required to toil 12 or 14 hr. a day. In an increasing number of industrial organizations the worker cannot be fired or transferred except for due cause. The chances of being injured on the job or of incurring some other type of occupational disability have been greatly reduced. If a worker is injured, there is a fair chance that he will receive some compensation for his disability. These benefits are illustrative of some of the gains derived from a consideration of the worker's part in production—gains not solely to the advantage of the worker but also to society in general, actually significant contributions to the general welfare.

Despite these recognized gains, questions may be raised concerning the human phases that have been neglected, or the undesirable social consequences that have sometimes occurred. No one will champion the view that the benefits to either the worker or society have been sufficient, and this can be taken to mean simply that the task is not finished. Questions still remain, however, concerning the appropriateness of the direction taken by past efforts, and the adequacy of the psychological factors upon which these efforts have been spent. Shorter hours of work provide the opportunity for a fuller life, but they do not ensure that the worker will attain this fuller life. Improvements of working conditions may prevent the worker from becoming completely exhausted, but they do not guarantee that the work will come within the psychophysiological limits of the worker. Protection against accidents and compensation for disability may lessen the worker's fears, but they fail to ensure freedom from worry. Something, then, is lacking.

The attack on the human factors in industry has actually been indirect. The changes introduced were centered upon factors external to the worker, and they dealt with conditions that were peripheral to the mainsprings from which his efforts arose. A homely analogy might be considered here in order to point up the nature of the difficulty. We lead our horse to water, but he does not drink. In order to induce him to drink, we attempt to improve the situation by presenting the water to him in a fresh, clean bucket. We are puzzled when he still refuses to respond. We become further perturbed when he continues his indifference after we add sugar as a further inducement. Certainly we have endeavored to recognize and take advantage of the equine factors in the situation. We think we have provided all that a horse would desire, but our inducements continue to be inadequate. Having failed in our efforts, should we maintain that we have a complete understanding of the psychological factors which are really important in the situation, and that the failure is to be attributed to the "orneriness" of the horse? Is it possible that we have overlooked something? Perhaps the horse is not thirsty!

The approach to the understanding of worker behavior should be directed to the motivational forces and the cognitive processes of the individual. Interest should be centered upon the worker as a thinking, feeling, and desiring organism and *not* as a mechanical device that responds in given ways to appropriate stimuli. Installation of a bonus system in a plant may result in no change whatsoever in production. The explanation of the failure lies not in the inadequacy of the system, but in the fact that no account was taken of the workers' attitudes toward, and understanding of, such a system. If a bonus system appears desirable to the workers and is meaningful to them, then their response is likely to be favorable, and their enthulsiasm will be a function of the degree to which their personal motives are satisfied.

Reverting to our analogy: a *thirsty* horse *will* drink. To know whether or not our horse will drink, it is necessary to know whether or not he is thirsty. To know whether or not a bonus system will bring about higher levels of production, it is necessary to have information concerning workers' reactions to such a system. Rather than attempt blindly to improve production by offering shorter hours for greater speeds of work, we should center the attack upon getting an understanding of the factors the individual considers important in the working situation. If an improvement in the accuracy of foremen's ratings of workers is desired, it should prove more fruitful to discover foremen's attitudes toward the rating of employees than to devise a better rating scale. Human problems in industry, then, should be attacked at their center, the psychological man, and less interest should be devoted to indirect ways of studying them.

It is obvious that it will be more difficult to understand the various motivating forces actuating the worker than it will be to classify suggested systems of financial incentives; that it will be harder to learn about the personal and social factors influencing foremen's ratings than to devise a new rating procedure; that it will require more effort to develop a procedure to ensure that the worker completely understands his job in all its implications than to develop a series of simple lectures on effective work methods.

Knowing that difficult problems lie ahead, we must exert greater effort. Recognizing the complexities that the human factors will offer, we become aware that it is extremely important that we keep informed as to the dependability of our methods. We must be careful with our definitions. The implications of our interpretations must be given thorough consideration. Generalizations must be made with caution. The method we use in attacking these human problems must be suitably geared to them in terms of exactness, specificity, and impartiality. The only method meeting these requirements is the method of science, which requires systematic rather than casual study and which bases its conclusions on fact rather than opinion. Nonscientific solutions to human problems in industry are possible, but their dependability can never be measured or predicted. In the following pages consideration will be given to the application of the method of science in the study and solution of human problems in industry.

SCIENCE AND INDUSTRIAL PROGRESS

Contributions of the Physical Sciences.—No one will dispute the fact that industrial progress has come about, either directly or indirectly, through the contributions of the physical sciences. Growth has come through successive technological improvements that have issued primarily from the research work of physicists, chemists, and engineers.

In the early stages of this growth, advancements came sporadically as individuals here and there gained insight into ways of improving older methods and procedures. These were bright individuals, but they lacked formal training. Their natural bent led them to become less interested in operating their machines and more interested in understanding how their machines operated. These so-called "inventors" desired to get the work done better, and this, more often than not, meant faster. Very frequently the machines they invented would require only one or two operators and yet would produce the work equivalent to that accomplished by a score or more workers.

With the organization of technical schools and research departments within colleges and universities, a great impetus was given to industrial expansion. Through formal school training thousands of individuals became acquainted with the general method of scientific investigation and with the special techniques and procedures by which this method could be utilized in solving a variety of problems. Armed with this knowledge and experience, many of these individuals entered industry, where, because of their greater insight, they detected and solved industry's problems at a rate far greater than that of their predecessors.

So remarkable was the contribution of these formally trained men that the larger industries saw the need and importance of establishing special departments in which such scientists could direct their efforts solely to research work. This step, although requiring considerable expenditure, proved to be of great advantage, and research divisions of larger organizations came to have as much importance as any other division of the company. At the present time some of these industrial research departments rival the best that can be found in large universities and colleges. All problems that had to do with the physical methods and processes of manufacture were brought under the surveillance of these specialists, so that a continued improvement in the processes of production was assured. Their attention was particularly focused on the discovery and development of new methods and new products. The discovery of products to satisfy old wants in new ways and to satisfy newly created wants became the major interests of these physical scientists.

Science Applied to the Worker.—One of the most prominent and persistent facts that has emerged from the rapid development of industry is the importance of the role played by the worker. In the early stages the worker was a mere chattel to be dealt with as a machine in any way the employer saw fit in his effort to effect the greatest output with the least cost. The fundamental function of the worker was to produce, and the more he produced the better worker he was considered to be. Changes in techniques and procedures were introduced to make the human machines turn out more work. Obviously the emphasis characteristic of the physical scientist in industry was adopted by those individuals who dealt with the human phases of production.

It must be acknowledged, however, that the investigators concerned with the human problems varied widely in their backgrounds and training and in their points of emphasis. A review of the work of some of these individuals shows them to be charlatans, who entered the field solely for economic gain. They had insufficient insight to realize the complexity of the problems to be solved or to acknowledge the deficiencies and limitations of the procedures that they offered as solutions. Other individuals, who had been concerned with the physical phases of production, saw the necessity of studying the human problems and endeavored to apply scientific methods to their solution. Many sound solutions were effected by them. Some of these investigators, however, adhered too strictly to the principles of mechanical science in their analyses of human responses, with the result that some of the procedures they devised and put into operation created more serious problems than the problems they had been designed to remove.

Lastly, there were investigators whose training had been in the techniques and methods of psychology or related fields. These individuals endeavored to apply the principles of psychological science to worker problems. The success they achieved was commensurate with the complexity of the problems that they attacked and with the degree to which they adhered to the disciplines of the scientific method. Their numbers at all times were extremely small compared to the needs and opportunities for studying human problems afforded by industry.

The over-all success attained by these earlier investigators of human problems did not rival the achievements of the physical scientists. This can be accounted for rather simply. The worker must be regarded as being *more* than a machine. When new procedures and techniques were given to him, he not only adapted to them but, as a human being, underwent changes in feelings, motivations, incentives, ambitions, and ideals, and many of these psychological changes were in the direction of deterioration rather than improvement. As a human being he understood the purposes of the changes in methods of work introduced in his job, and if he disapproved of them or disliked the pressure being applied to force him to adopt them, he could balk and refuse to comply. He could go even further and combine his efforts with those of other workers to resist the enforcement of these unwanted methods. These various steps to oppose management were within his power, and he frequently made use of them. Much dissension then occurred between the workers and their employers because of the efforts of the so-called "efficiency experts" to force the adoption of changes that the worker considered inimical to his interests. In the solution of problems involving the worker it is necessary to take account of his individual attitudes and desires. Because this simple principle was ignored, procedures that were to the advantage of both the employee and employer often failed. Yet those procedures should have proved extremely successful.

SOME ERRORS IN THE APPLICATION OF SCIENCE TO THE WORKER

The industrial unrest prevalent today arises largely from failure to resolve employee-employer differences. It was suggested above that part of this dissension can be traced to mistakes made in applying scientific procedures—and procedures that cannot be classified as scientific—to the human problems of work. To understand these mistakes is to take the first step in the prevention of their recurrence. It is not possible in a few pages to describe all the types of errors committed in the industrial applications of psychological science, but certain major errors are deserving of consideration. Just how much these errors have contributed to labor and management differences is impossible to determine, but that they contributed to the widening of the gap between employer and employee there can be no doubt.

One-sided Use of Scientific Results.—The first error to be discussed is an error in the direction of the focus of scientific studies, with a consequent one-sided application of the results obtained. This can be made plain simply by saying that the focus of most of the scientific work was upon a reduction of manufacturing costs and an increase in profits. It will be remembered that the physical scientist was hired by management and was therefore responsible to him. The scientist's task was to invent methods and machines that would shorten and speed up manufacturing processes and at the same time reduce the costs of production. As a result of his work, there was a tremendous industrial expansion, which provided the necessities and luxuries of life in such abundance that a marked increase in the level of the standard of living resulted for everyone. No one questions the fact that this was a superlative achievement of the physical scientist. The primary motive of management in hiring the scientist, however, was not to raise the standard of living. Rather the aim was increased profits, but as an accompanying result there were profound improvements in the standard of living.

When nonscientists and scientists entered industry to develop the worker phases of production, they adhered to the same philosophy. They were hired by management to step up the worker's production in order to increase profits. They were responsible to management, and the tenure of their jobs rested primarily on their ability to develop higher levels of production or lower costs. It is not intended to paint a one-sided picture, as is sometimes done, depicting the industrialist as a greedy profiteer who is solely interested in bleeding the worker in order to guarantee himself a life of luxury. Happily this has not been characteristic since the early days of the industrial revolution, even though a few situations reminiscent of the early exploitation of the worker occasionally still exist. The argument being made is not against increasing profits but rather against directing all studies of the human phases of work toward the increase of economic returns.

The scientific method, which many investigators championed as containing the only promising solutions, was fettered from the beginning by this misdirected focus. The problems needing solution were not restricted solely to problems of production and profits. In so restricting their studies, these early investigators failed to collect facts on other problems that have contributed greatly to present day employee-employer dissension.

Misconception of Worker Factors Contributing to Production.—This error refers to the failure to isolate and study all the various human factors influencing production. Attention of early investigators was centered mainly upon those human factors objectively observable and directly concerned with productive activities, such as the sensorimotor coordinations required to perform a task, or the speed with which the hands or fingers could manipulate materials. Likewise their attention was focused upon those activities which had immediate consequences in production and which, if improved, would register their effects on production within a few days rather than within a few months or years.

It should be apparent that this error was in part a result of the misdirected focus already discussed. Holding immediate profits uppermost in mind would be conducive to increasing the attention values of the factors just described and would decrease the attractiveness of the more intangible factors that might still be of great significance to the man actually performing the work. In part the error is also to be ascribed to ignorance on the part of the investigators concerning the fundamental principle of the unity of the human organism. This can be attributed to their lack or narrowness of scientific training and preparation, and to their willingness to champion and advance false systems of analysis not soundly based on facts.

Most of these investigators conceived of the worker as a producing machine, capable of the reception of certain stimuli and the execution of certain responses. Since these two activities were the only ones that the investigators considered to be logically and mechanistically necessary for work, they were the only ones exhaustively studied. This marked restriction of the field blinded the investigators to the importance of the less obvious, less mechanical, and more intangible, more remote psychological factors determining the effectiveness of human work. Personal motives, individual feelings of pleasure from creative work, self-satisfaction from achievement, and the necessity of the job fulfilling remote individual goals and purposes were not even recognized; therefore the investigators did nothing to learn about the influence of these factors on the worker's behavior. As a consequence, they overlooked the fact that these are the most important factors determining the productivity of workers. Indeed, it is only in relatively recent years that the importance of such factors has been recognized.

In addition this misconception of the unity of the worker as a personality resulted in failure to follow all the ramifications of the effects of the various changes in procedures, methods, and techniques that were introduced from time to time. Profits were the criterion of the value of all new changes. That a change might have adverse effects on the attitudes, interests, and motives of the worker was either not acknowledged or, if acknowledged, was considered to be of no consequence. The number of items produced at the end of the day was the only criterion that was examined. Eventually worker resentment showed itself as a culmination of the detrimental effects brought on by the changes made in the name of efficiency. At last it became necessary for the investigators to acknowledge factors other than simple production figures. Even then, however, they directed their efforts toward placating the worker, in order to get his cooperation in the adoption of further "efficiency" procedures, rather than toward a study of the effect on production of the attitudinal factors that had arisen from the enforcement of previous procedures.

Temporary expedients were used to put over new changes in the face of this rebellious attitude of the worker. In the beginning, various financial incentives were utilized to get cooperation. Bonuses, higher wages from piece-rate payment, higher hourly rates of pay, and other similar means were used to convince the worker of the value of the new methods. These schemes were successful for a short time, but eventually they proved insufficient against the mounting discontent and resentment that accumulated. Frequently workers would refuse to cooperate, despite very "rosy" inducements in the form of financial returns. At first these refusals came as a surprise to employers. They could not understand why workers, who could readily make use of any increase in wages given them, would consider certain other objectives as being of greater value than the proffered financial inducements. What was needed was a clearer understanding of the principles underlying human motivation, and a knowledge that in the unified individual the effects of every activity ramify throughout the personality and thereby influence behavior in countless ways. Only by evaluating these ramifications is it possible to arrive at an understanding of the causes of human behavior.

Failure to Take into Account Well-established Psychological Principles.—A third error of significance in evaluating the outcome of the early studies of human work concerns the failure of the investigators to take into account well-established psychological principles. The reference here is solely to basic findings that had been firmly established, which were available for the consideration of the early research workers, and which, therefore, should have received their attention. By way of illustration we need here consider only three: the facts of individual differences, individual variability, and the integrative nature of human behavior.

One of the features lying at the core of modern industry is standardization. Greater effectiveness in production was achieved by the physical scientist when he devised machinery that standardized the manufactured product. This standardization also greatly increased the desirability of the product in the mind of the consumer. Procedures of work likewise were standardized, such as the time sequence of the several steps involved in manufacturing an article, or the direction or sequence followed in routing materials through different departments. Again, increased effectiveness in production followed the installation of these procedures.

The next step which followed logically, was the standardization of the particular responses made by the worker as he manipulated materials in performing his job. Up to this point the changes had involved principally the arrangement of materials and time sequences in routing materials, and the worker's responses were only indirectly affected. Now the standardization was to require all workers doing a given job to perform that job in exactly the same way.

There was some justification for investigating the standardization of worker responses. It was noted that some workers produced considerably more than other workers. Study of the workers on the job revealed a wide variation in the specific responses utilized in accomplishing the same task. The methods of superior and inferior workers were compared and found to differ widely. This finding naturally led to the adoption of the method of the superior worker as a standard to be followed by all other workers.

Obviously the attempt to enforce all workers on a job to adhere to the particular types of coordinations, the particular sequences of responses, and the particular time relations between the responses—all determined from the best worker on the job—completely ignored the fundamental law of individual differences. No attention seems to have been given to the fact that other workers might find the standardized responses very difficult to perform and might use considerably more energy in accomplishing a given amount of work with the standard responses than if they were allowed to use their own particular responses.

The standardization of work methods also presumes a high degree of consistency in the performance of the individual worker. Complete consistency, however, is not characteristic of human performance. An individual's performance varies from time to time and under a variety of conditions. The truck driver who today is a safe and careful operator may tomorrow be involved in an accident and cited for traffic violations. The typist who is slow at the beginning of the day may pick up speed as the day progresses. The salesman who is cheerful now may be indifferent later. This is not to imply that human behavior shows no consistency whatsoever, but rather that it is far more variable than the performance of the machine that has received so much attention from the physical scientist. The latter, who is accustomed to variations in fractions of a per cent, can hardly appreciate the extent of the fluctuations in behavior of the worker who must tend the machine.

The implications of individual variability are many but were not given due recognition in earlier investigations. Following are two examples. In developing a "best method" of work the particular set of motions found to be quickest and most effective when the worker was fresh and rested was adopted. But this set of motions might not have been the best when the worker was tired and had worked for a long period of time. Yet under the standardized method of work he was expected to follow exactly the same sequence of motions throughout the entire day. In evaluating the qualifications of a worker, as in an employment interview, only a small sample of his behavior would be taken into consideration. The worker was given an interview lasting from 5 min. to ½ hr., and it was assumed that the assessment made of him was characteristic of his performance at all times under all circumstances. By failing to consider the possible fluctuations in the individual's performance over a period of time, the assessment made of him was usually inaccurate. If the facts of individual variability had been fully appreciated and taken into account, the result would have been higher levels of production together with greater worker satisfaction.

For many years psychologists have been stressing the fact that human behavior must be considered as an integrated whole. The concept of the individual as a simple reflex machine responding now to one stimulus and now to another without any patterning or interacting of responses is no longer tenable. The principle of integrated behavior was largely ignored by the earlier investigators when they attempted to study and control the behavior of the worker. This is not an unexpected result, since they were accustomed to dealing with machines. A machine is an assemblage of more or less independent parts. If a certain mechanical movement is necessary to accomplish a given function, it makes little difference so far as that function is concerned what particular mechanical arrangement or principle is used to accomplish the movement, so long as the movement satisfies the necessary requirements with regard to speed, extent, and the like. Human behavior, however, is not so independently constituted. The characteristics of any given response are conditioned by the whole pattern of other responses among which it occurs. The manner in which a batter swings at the pitched ball will be a function of the number of strikes or balls already called on him, the number of men he sees on base, the length of time he has played the game, the extent of his financial indebtedness, and many other factors.

The physical scientist, in attempting to standardize the activities of the worker in connection with his job, committed the error of championing an atomistic conception of human behavior. He observed the movements of various workers, noting the movements which were most rapid and presumably therefore most effective, and by selecting one movement from one worker and another movement from another worker, he attempted to create a new and quicker method of work, which he made the standardized method. It may well be that this procedure achieved the success it did because of the adaptability of the human organism rather than any excellence of the method.

Failure to Clarify Concepts.—One of the most serious errors committed, and one still frequently overlooked, was the failure to clarify concepts. This resulted from the general tendency to accept the use of words and phrases as if all persons were in agreement in regard to their meanings. Objectives were stated in nebulous and ambiguous terms, and descriptions of analyses were incomplete and inconsistent. When dealing with human behavior, the need for clarification of the concepts under consideration is particularly important and doubly difficult. It required far less effort to use the ambiguous language already established than critically to examine past usage and clarify the needed concepts. By way of illustration let us consider a few concepts that, although widely used in labor-management relations, suffer from lack of clarification and consequently serve as sources of disagreement and mutual distrust.

By common agreement it is held that fatigue is an undesirable condition of the worker. Thus it was decided that workers on the more fatiguing jobs should be paid at a higher rate than those on less fatiguing jobs. This seemed reasonable to all parties concerned. There remained, however, the decision as to which jobs were the more fatiguing and which were the less fatiguing. This area was one of major disagreement. Some of the questions that arose were the following: Is a job that makes greater physical demands upon the worker more fatiguing than one in which the demands are more mental? Is a job in which the working week is 40 hr. less fatiguing than one in which the week is 44 hr? Is typing more or less fatiguing than the operation of a calculating machine? Inasmuch as the concept of fatigue was not clarified, questions such as these could not be answered. It is obvious that the continued performance of manual labor will have different effects on the worker than continued performance of office work. Yet in both cases fatigue is the term used to describe the state of the worker. It will be pointed out in a later chapter that fatigue has several meanings and is frequently confused with the concepts of effort and monotony. Until the concept of fatigue is clarified, no accurate description of the demands of different types of industrial work upon the human being can be effected.

Another term that needs clarification is productivity. A worker is said to be ineffective because he is unproductive. One method of work is said to be superior to another because it results in higher levels of production. Productivity is dealt with as if there were unanimity of agreement in the meaning assigned to it.

In the past the emphasis was on amount produced and by implication this meaning also included the quality of work. Thus, a typist was termed productive because her speed of transcribing was rapid. Often no mention was made of the number of errors, indicating that inaccuracy was presumed to be insignificant. Speed and quality of production do not necessarily go hand in hand, and using the term *productivity* in a general sense obscures the fact that two different variables are being considered.

The term productivity also was confused with other indices of effectiveness of work. A worker who was judged to be superior because of such qualifications as cooperativeness, loyalty, and punctuality was likely to be termed productive, regardless of the quantity and quality of the work he turned out. Obviously, as long as the term was given several different meanings it was impossible to set up a standard of effectiveness that could be used to evaluate all the different aspects of worker effectiveness.

SOME NEW EMPHASES IN THE APPLICATION OF PSYCHOLOGICAL SCIENCE

An examination of the more recent developments in the study of human problems in industry reveals the beginnings of certain new emphases showing promise of a sound reorientation of the application of scientific methods to the solution of these problems. These emphases are forming as the result of several contributing factors, one of which can be described as "profiting from experience." There is no doubt that industrialists have learned a great deal from the mistakes of the past. Errors resulting from the misapplication of the scientific method now point the way to sounder research. Science has increasingly furnished the framework on which progress in industrial production has been built, and its concepts have permeated all phases and branches of industry. The industrialist, through being exposed to scientific method for many years, has gained an insight into many of its characteristics. Its promise of successful application in all fields has been forcibly brought to his attention, and his understanding of the scientific approach has resulted in his having a more critical attitude toward its application. A further factor, and one which has contributed to the developments just referred to, is the increase in numbers of trained personnel who have entered industry in recent years. Trained personnel in production engineering, scientific management, and applied psychology have contributed to the general improvement of the research done on human problems.

At the present time the new emphases are not yet widely accepted in industry, but there are signs that they are continuously growing in favor. Using them as guiding principles in the research of the future should eventually bring forth results that will justify their being given a widespread application throughout industry.

Science Must Function Unfettered by Allegiances.—It has already been pointed out that individual scientists, both physical and psychological, have been responsible to management, and that this resulted in focusing the research and interpreting the results in favor of management. Scientific research means unbiased research, and it is difficult to see how a scientist can long be unbiased when he knows that his job depends upon getting results that favor one of two disagreeing parties, especially when the parties have conflicting objectives. It is true that, as a method, science can be used to investigate any problem, but it is also true that the determination of the problems to be investigated will condition in great measure the particular applications that are formulated from the results of the research. Regardless of the particular individuals who will be affected by the solution to a problem, science should be free to investigate any and all facets of the problem, so that all facts will be available for the formulation of the solution.

It must be remembered that there can be no scientific research without a scientist, and that there are many points throughout the progress of the research at which the judgment of the scientist enters as an important contributing factor. When the judgment is biased by the warping effects of some restricted point of view, the chances are high that the findings will not include all the facts, and that the interpretations will be in error. The aim of the psychological scientist in industry is to solve the human problems, and he can best do this when he is free to follow the lead of facts and not of bias. He cannot accomplish this purpose if his point of view is restricted by some allegiance. As a price for its answers, science demands unbiased research.

Research Must Be Conducted within a Broader Perspective.—In the past, restriction of industrial research through biased perspective caused scientists to ignore many problems connected with the human phases of work. Likewise, warped viewpoints in interpreting the significance of results prevented the investigators from seeing the importance of measures of effectiveness that were not encompassed by the criterion of profits. A broader perspective will follow when restrictions on research are removed. This perspective should encourage the use of science in the solution of all problems arising from the adjustment of the worker in his job. There will be a recognition of the principle of the unity of the total personality. The worker no longer will be considered a mere machine before a bench, but will be regarded as a complex of interacting abilities, interests, motives, drives, desires, traits, etc. His personal, social, and family, as well as work goals will be studied, and efforts will be made to combine them into a harmoniously functioning motivational system.

No longer will the items produced at the end of the day be the sole criterion of a worker's proficiency. The effectiveness of a new work method will be judged in terms of a wide variety of criteria, which will encompass all the effects created by that method. The speed of work will be evaluated not solely in terms of output but also in terms of the energy expenditure of the worker and the boredom he experiences. In this larger perspective the emphases will be upon the worker in his job and not upon the worker as a productive machine.

A Reinterpretation of "Production for Maximum Profits."—If the statement were made that in the new emphases psychological science was to be applied to all human problems in order to adjust the worker for maximum production, it immediately would be interpreted as a restatement of the aims of the older investigators. This is not true, however, when maximum production is reinterpreted in the light of the larger perspective mentioned above. The older point of view applied the meaning of "maximum production for maximum profits." The newer meaning is "maximum production consistent with the abilities, energies, interests, and motives of the worker." The studies of the past have amply demonstrated that a worker's production is closely dependent upon his personal goals. Maximum production will be obtained when the work and the worker's goals are in harmony. To achieve this is not an impossibility; not to achieve it is to have less than maximum production, regardless of the particular work methods which may be enforced.

The new emphases, however, do not minimize the need of profits. It has never been satisfactorily demonstrated that industrial enterprises can be successfully run without profits, nor even with a minimizing of profits. The solution of human problems of production in terms of workers' motives and abilities does not mean the elimination or even the reduction of profits. The new emphases do not oppose profits, they merely affirm that profits cannot be indiscriminately applied as the sole criterion of the effectiveness of each and every change introduced to improve working conditions.

The new emphases will not only encourage the maintenance of maximum profits but will urge the increase of profits within limits consistent with sound industrial progress and continuous industrial peace. Under the new emphases profits will be interpreted as belonging to both parties concerned. Profits then will mean as much to the employee as they will mean to the employer. The worker will be motivated to produce at a maximum level, because he is receiving his just proportion of the financial returns.

Why the New Emphases Seem to Favor the Worker.—From a consideration of the emphases discussed above, it might be concluded that the scientific investigations of the future are to be centered upon the needs of the employee to the exclusion of the interests of management, and that therefore a biased focus of the research again will be established, but this time in favor of the worker. This is not the intention. The new emphases are oriented around neither management nor labor, but rather around the needs of both.

These emphases are also referenced to the social good and the needs of industrial peace. The social ramifications of industrial unrest result in serious consequences. The day may soon arrive when neither the employee union nor the employer association can disrupt the social peace of whole communities because of disagreement on problems of policy that are strictly within the employer-employee relationship. The solutions of employer-employee problems have implications for society at large, and therefore it is impossible to set up sound research policies without the inclusion and consideration of more general social factors.

The reasons for orienting the emphases toward the welfare of the worker are not difficult to understand. The question may be asked, "Which one, the employer or the employee, is primarily restricted to the production line because of the nature and amount of his abilities?" The answer is obvious. The worker manipulates the materials, runs the machinery, and operates the processes that manufacture the goods. On the other hand the task of the employer is one of discovery, of organization, and of long-term planning. Actual day-to-day production, which is the primary objective of both employer and employee, can be better facilitated by investigating the problems of the millions of individuals on the production line than by investigating the problems of the few who are directing the production. Any cessation or slow-down of production is going to have an immediate effect on the employee, but only a delayed effect upon the employer. It is going to affect large numbers of people first and therefore it will have immediate social consequences.

The argument for the new emphases should not be misunderstood. There is no intention to minimize the importance of discovery, of organization, or of supervision, which are considered vital to all production. There is no intention whatsoever to whip up favoritism for the worker. Science should play no favorites. The new emphases should follow the lead of facts. The facts point to the "sore spots" of production lying with the worker. Most of the human problems originate in factors concerned with the values that the worker sets on his work. The origin of values and the factors conditioning values can be investigated scientifically, and it will be found that to obtain all the facts will necessitate the study of *all* phases of human work. Therefore, if the human problems in industry are to be solved, research must be directed to the focal point of the problems, viz., the worker and the values he places on his work. It is toward this end that the new emphases are leading.

CONTRIBUTIONS OF PSYCHOLOGICAL SCIENCE

The rate of progress in scientific investigation is conditioned upon the nature of the problems to be studied and the amount of traditional lore available from the past for application to these problems. Progress in research on human problems in industry will be slow because of the complexity of the causal structure underlying human behavior. There is some groping in all sciences, and this groping is less directed, and thus more subject to error, in disciplines where human behavior is concerned. Groping, however, is reduced as research findings accumulate. Psychology and its related disciplines are not entirely out of the stage of undirected groping, and there are still spheres in which they cannot boast of having well-formulated methods. Over the years, however, there has been established a very rich background of experimental findings, and advantage should be taken of this background in determining the solutions to worker problems.

A description of what psychology has to offer in the field of industry will form the main portion of the chapters to follow, but at the outset it will prove of value to consider briefly the form in which these contributions may be manifest.

Psychology Offers Few Ready-made Solutions.—Psychological science has few ready-made solutions to offer. This means that there are very few problems in industry for which solutions now available fit well enough to allow the psychologist to predict with a high probability of success.

The industrial scientist's specific procedures and techniques usually are developed in research laboratories. In the laboratory situation he is able to set up the necessary controls to isolate and to study the variables completely. When the findings of such experimentation seem applicable in practice, and the conditions of the laboratory are duplicated in large measure in the practical situation, there is then a high probability that the same results will be obtained in practice as are found in the laboratory. This is the condition usually found in the physical sciences. A machine, an electrical control device, or some physical or chemical process developed in a laboratory may very frequently be directly and immediately applied in industry because the conditions of practice are closely similar to those of the laboratory.

The picture found in psychological science is considerably different. The factors operating in the psychological laboratory to produce a given result will seldom be duplicated in the practical situation. This is due primarily to the nature of the subject matter involved. For example, suppose a new work method is studied in the experimental laboratory and found very effective. There is no guarantee that the method will meet with similar success in a factory. The causal factors are not identical in the two situations and actually may be very divergent. The intangible motivating factors activating the individuals in the experimental laboratory will not be the same as the motivating factors activating the workers in a factory. As the psychological task studied depends less and less on intangible motivating factors, the more successful is the psychologist in discovering in his laboratory procedures that will prove successful in industrial situations.

There is a ready solution to this difficulty, and that is for the scientist to perform his research under conditions duplicating those of industrial practice. The findings then would have direct application. To do this would require that industrial and union organizations jointly provide the means for establishing research groups within the industrial organization.

Psychology Can Offer Many Hypotheses.—The best substitute for a ready-made solution is a hypothetical one which is supported by evidence indicating that it has a high chance for success. The chances for success of hypotheses vary from zero to almost certainty. Just what the chances are for any given hypothesis is dependent upon many factors, the most important of which are the following:

1. The degree of similarity between the practical situation and the laboratory (or other) situation in which the hypothetical solution was evolved
2. The accuracy with which the initial studies were executed
3. The amount of evidence supporting the solution that may be obtained from related studies or experiments

Psychological science contains hundreds of thousands of experiments, covering a very wide range of situations involving human behavior. Nearly every conceivable human factor has come under study at one time or another, and for some factors there are large numbers of experimental findings covering a wide variety of different situations. This storehouse of material is a rich source of ideas that will prove of great usefulness when applied to the human problems of industry.

It must be borne in mind, however, that any generalization that is selected for trial must be accepted as only tentatively true. The adaptation of any finding to the industrial situation is made with a weathered eye of skepticism, and careful checks are made of its success under the new conditions. Only when evidence is gained that the finding is successfully operating under the practical conditions of industry can it be advanced as deserving of wider adoption.

Psychology Can Offer the Scientific Method as Adapted to the Study of Human Behavior.—The application of the method of science to any subject matter requires various adaptations and modifications, which are imposed by the nature of the subject matter. The broad framework of science remains the same, and the larger steps of the method remain practically undisturbed. The individual processes and the specific techniques are adjusted to the subject and take on the form most suitable to the particular situations or conditions to be studied.

Psychological science can offer the method of science as it has been specifically adapted to the study of human behavior. Within the framework and general outline of the method many specific procedures and techniques have been devised in attempts to subject a variety of causal factors to scientific scrutiny. These special adaptations have to do with every phase of the method. Some are involved in setting up the problem to be studied, others for isolating the variables to be measured. Some are involved in the introduction of controls for separating the effects of related factors. Still others are involved in analyzing the data and statistically testing the significance of hypotheses. Most of these specialized procedures and techniques will prove of value when applied to industrial problems.

Psychology Can Supply Trained Personnel.—The scientific method can be accurately used only by those especially trained in its application. Many mistakes of the past can be traced to the inexpertness of those who conducted the studies. Usually the industrialist agrees with the general notion that the engineering phases of production should be in the hands of trained engineers, and that as these phases become more complex the requirements the individual must meet in order to hold the job should also become more technical. Unhappily this has not been the rule followed in the case of the human phases of industry. Personnel problems are frequently left in the hands of a minor executive who is neither qualified nor interested in this type of work.

For the most part, trained personnel must come from the colleges and universities. In past years academically trained psychologists have not entered industry in large numbers. This condition is changing at the present time, and it is expected that in the future the challenge of industrial problems will attract into the field larger numbers of these highly trained scientists and technicians. Special courses of study are being instituted in some of the larger schools, through which the most proficient training possible will be given.

It is to be remembered, however, that upon graduation from college these trained personnel will not be fully prepared immediately to set up research programs. No one knows better than the scientist himself that the successful solution of any problem involves not simply a knowledge of a method but also a firsthand acquaintance with the problems and all their conditioning factors. Academically trained personnel must supplement their classroom preparation with firsthand experience of jobs and processes in industry. They must have time to acquaint themselves with the factors functioning in the practical situation. This points to the need of long-range research programs, for only after the scientist has gained this practical experience can he be expected to discover workable solutions for the complex human problems of production.

THE METHOD OF SCIENCE

So much has been written above about the application of the scientific method that a further description of the method itself is in order. To begin with, the reader unfamiliar with science will not find procedures in it that are totally unknown to him. Scientific method is not so much a unique method as it is a better application of methods already commonly used by most individuals. The differences between science and common-sense methods may appear at first glance to be of little consequence, but it is because of these characteristic differences that the scientific method has proved vastly superior to any common-sense procedure. In the following paragraphs the important features of the scientific method are briefly considered.

Facts the Basis of Science.—The scientist predicates all his judgments and evaluations on fact. A fact is defined broadly as being any occurrence, happening, experience, or phenomenon. One of its most important characteristics is that it is impersonal. This means that a fact, although dependent upon human observation, is independent of any particular observer. A fact can safely be used without knowing its discoverer, as contrasted with an opinion that can be used wisely only when the qualifications of the person expressing it are known. Facts are the backbone of the scientific method.

Emphasis upon Objective Observation.—Science endeavors to study its phenomena objectively and only appeals to subjective observation when compelled to do so. With objective observation, more than one person can experience the phenomenon. There can then be a duplication of the experience, and one observer can check upon the other. Certainly several observations are better than one, especially when the situation is complex and not all its features are fully understood. Agreement among observers is an important condition of the scientific approach, and it is more readily obtained with objective than with subjective observation.

Systematic Rather than Casual Study.—The study of a problem by scientific procedures requires a systematic attack. The problem is comprehensively investigated from as many angles as possible. One of the important goals of the scientist is to get all the facts. Therefore he will leave no stone unturned in his effort to obtain a complete description of the problem. It is analyzed into all its parts, and the ramifications of these parts are traced and studied. The influence of each factor upon the others is determined, and the parts are assembled and patterned again into the whole. No aspect of the problem is neglected, and each assumes its rightful importance in the composition of the completed picture.

Science Utilizes Experimental Controls.—To gain knowledge concerning the influence of a given factor, the scientist utilizes various forms of control that will enable him to check on the operation of the factor when its effect or contribution is not being masked by the operation of other related factors. Very frequently the success of an investigation is directly conditioned upon the degree of control attained over the relevant variables, and often more effort is expended in

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devising means to attain this control than is spent in conducting the actual study. The scientist takes advantage of the experimental method to set up separate experimental trials on various phases of his problem. Facts are gained by trial, or pilot, runs, which are conducted under the exact conditions prevailing in the real life situation, insofar as this is possible. As contrasted with the practical situation, the experimental situation provides more adequate control over the various factors operating in the problem under study.

Science Utilizes Quantitative Description.—Measurement is one of the most important features of the scientific approach but a difficult one to achieve in the field of human behavior. It forms the basis of prediction, and without it there is little left on which to determine the expectations of the future. Quantitative scores or measures form the basic facts with which the scientist works. They contain the answers to his problems, but usually they do not yield these answers without considerable manipulation and analysis. Quantitative facts by themselves have few significant meanings. Their full import is gained only when they are related and formed into complex arrangements and patterns. This process of evaluating the quantitative data is a discipline in its own right and involves the utilization of many techniques of a statistical nature.

Science Demands Trained Personnel.—The method of science implies a scientist to conduct the operations. The full meaning of this statement is not always realiezd. The scientific approach does not consist of a few simple rules that, when followed meticulously, will produce the needed facts. Scientific method is as sensitive and precise, and as reliable and comprehensive, as the training, ability, and dependability of the scientist. Its correct application depends upon trained personnel, and this condition is as true for the field of human behavior as it is for the field of physical science.

Science a Self-corrective Method.—In contrast to other approaches the scientific method provides for correction of results. Generalizations must be based upon facts, and at all times an attitude of doubt and questioning is encouraged. He who applies it hesitates to rest the case at any time but continuously endeavors to improve the generalizations through seeking further evidence. No claim to infallibility is made, and any new evidence whether positive or negative is incorporated into the picture, and modifications are made if the new facts demand them. Explanations are finally accepted because there are no better alternatives.

CHAPTER II

JOB AND WORKER ANALYSES

A knowledge of job and worker analyses is a fundamental prerequisite for an intelligent attack upon all personnel problems in any organization, whether large or small, public or private. Unless a personnel officer has adequate knowledge of the nature and requirements of the job for which he is interviewing an applicant, he is not in a position to obtain the needed personal data from him. Without information concerning the interrelationships and interchangeability of jobs, it is impossible to make a satisfactory ruling in the case of a worker, who, for example, is a drill-press operator claiming to be unemployed and therefore eligible for unemployment insurance, but who does not apply for the job of punch-press operator, which is available to him. The most profitable beginning in the development of more effective methods of work is a study of currently employed methods. A decision as to the optimal shape for the handle of a screw driver can only be made when there is a clear-cut notion of the specific kinds of tasks in which the screw driver is to be used. One of the first steps in attacking any employment problem, then, is to make an adequate analysis of the jobs under consideration.

THE MEANING OF JOB AND WORKER ANALYSES

Definitions of Terms.—The terms *job* and *occupation* have been used in a variety of different senses. Sometimes they are used as synonyms, and on other occasions they are used to refer to different levels of grouping of industrial tasks. The most nearly standard terminology is that employed by Shartle.[1] This writer uses the following definitions of terms:

Position: A position is a group of industrial tasks that are performed by one person. In any organization there will be as many positions as workers. In an office, for example, there might be four positions of clerk typist, each of which would be filled by a different individual.

Job: A job is a group of similar positions. Thus in the above case the four positions of clerk typist would constitute the job of clerk typist in the organization. In any establishment there may be only one person or there may be many persons, engaged in the same job.

Occupation: An occupation is a number of allied jobs, *i.e.*, a family of related jobs. Thus one speaks of the jobs of clerk typist, comptometer operator, and bookkeeper falling within the clerical occupation.

We shall employ the terms *position*, *job*, and *occupation* in the foregoing meanings. The term *job analysis*, consequently, will refer to the procedures by which information is obtained concerning a specific job. The term *occupational analysis* will refer to the study of the relationships among the requirements of related jobs, and to the characteristics the jobs within a given occupation have in common.

Job Analysis and Worker Analysis Distinguished.—The term *job analysis* refers to the procedures employed in collecting information concerning the nature and conditions of the work involved in a given job, and the term *worker analysis* refers to the procedures employed in collecting information concerning the necessary or desired characteristics of the man who successfully works at the job. The results of a job analysis are set down in the job specifications or descriptions, and the results of a worker analysis in worker specifications or characteristics. Job analysis then is concerned with the methods and procedures of work and the administrative and physical conditions of work, characteristics given by fiat or fixed by custom and tradition. They are the specifications of the job that have been set down by law or prepared according to a plan before the actual work began, or specifications that have resulted from technological improvements, changes in the goods or services produced, the development of the organization, collective-bargaining conferences, etc. Although certain qualifications of the worker may be inferred from these job specifications, they do not actually define the worker requirements in any sense. It is the function of worker analysis to describe the personal requirements of the worker.

The Scope of Job Analysis.—A job analysis will yield information such as the following:

A. Present methods and procedures of work
    1. Duties—description of the tasks the worker is expected to do
    2. Materials, supplies, etc., the worker uses
    3. Tools, machines, and equipment the worker uses; description of the workplace
    4. Methods and procedures employed in carrying out the duties
B. Nature of the work
    1. Mental and physical characteristics
    2. Repetitive aspects
    3. Dangerous aspects
    4. Unhealthful aspects

C. Relation of this job to other jobs
    1. Helpers and assistants
    2. Coworkers
    3. Coordination of the work of the job with that of other jobs
D. Physical conditions of the work environment
    1. Place of work; inside or outside
    2. Conditions of illumination
    3. Conditions of ventilation
    4. Conditions of noise
E. Conditions of employment
    1. Methods of selection of employees
        a. Techniques used, such as tests, interviews, etc.
        b. Promotion or transfer from other specified jobs
    2. Length and hours of work periods
    3. Amounts and methods of pay
    4. Permanency or seasonality of the job
    5. Opportunities for promotion and advancement

The Scope of Worker Analysis.—A worker analysis will yield information such as the following:

A. Physical characteristics of the worker
    1. Health
    2. Strength and endurance
    3. Body size
    4. Handedness
    5. Permissible physical limitations
B. Psychological characteristics of the worker
    1. Sensory acuity
    2. Skills and abilities, such as manual dexterity, ability to do arithmetic problems, etc.
    3. Traits of temperament and character, such as honesty, emotional stability, etc.
C. Background of the worker
    1. General education
    2. Previous job experience
    3. In-service training

THE NEED FOR SYSTEMATIC JOB AND WORKER ANALYSES

Lack of Knowledge Concerning Jobs.—It is the rare personnel officer, executive, or foreman who openly professes ignorance of the nature of the work carried on by those under his direction. Nevertheless, in practice, adequate knowledge by superior officers appears to be the exception rather than the rule. There are many factors at work, aside from a lack of training in job-analysis techniques or even pure indifference, which may bring about a situation wherein a supervisor's conception of a given job is at variance with its actual nature, even though he may be in daily contact with the men working at it.

A given job does not remain constant from year to year. Over a period of time the product or service may be changed somewhat, thereby necessitating changes in the original procedures and conditions of work. Interested and ambitious employees will enlarge upon their assigned duties, while inferior ones may lose portions of their work to others or simply let them go.[2] In other cases, although definite duties may be assigned, the employees may unofficially interchange some of them. In instances of undermanning or overmanning, the actual work may of necessity differ from some planned arrangement.[3] It is important then for supervisors to be aware of the foregoing factors producing changes, if they are to maintain adequate knowledge of the requirements of jobs under their direction.

A study by Charters and Whitley well illustrates how incomplete may be the knowledge of an apparently clear-cut job.[4] These investigators set out to determine the different kinds of work performed by secretaries to businessmen and executives. The members of the research staff and six secretaries recorded all the secretarial duties they could recall and succeeded in compiling a list of 166 duties. In order to ascertain the completeness of this list, a chart was prepared covering a working week, each day being divided into time periods. Copies of this chart were distributed to 125 secretaries, who noted their actual activities as they performed them in each time period during the day. By this means, errors due to forgetting were reduced to a minimum, and an almost complete coverage of the actual duties of secretaries was assured. A tabulation of the duties from these charts revealed that 871 different duties were mentioned, over five times as many as there were in the original list.

If a group of experienced investigators working with six persons actually engaged on a given job were unable to compile anywhere near a complete picture of that job, it certainly seems highly improbable that the executive, who, only incidentally to his regular work, has the hiring and firing of his secretary to do, could have an adequate notion of the kinds of things his secretary is called upon to perform. Supervisors are much too confident of their knowledge of the nature and demands of the jobs they control.

Importance of Systematic Job and Worker Analyses.—The hit-or-miss methods, which commonly are employed in obtaining information about jobs and their demands upon workers, do not give satisfactory results. The information obtained by such casual observation will be far from complete and almost certainly will be inaccurate. Systematic procedures applied to problems in job and worker analyses are a necessity, if reliable and valid results are to be obtained.

The importance of systematic job and worker analyses is especially clear in the field of distribution. Since the very existence of private producers is dependent upon their ability to market their commodities and services, extensive market research studies often are made by progressive firms in order to discover the best selling techniques. The results of such studies are incorporated in carefully prepared advertising campaigns and in training courses for the salesmen. Although the importance of these procedures cannot be denied, it nevertheless appears that the producers are overlooking one important phase of marketing, viz., the exact delineation of who is a salesman.

The experience of a concern of milk distributors will serve as an example.[5] The executives of this firm disagreed as to the function of their deliverymen, some considering them only as laborers, and others as salesmen. An analysis of what the men actually were doing showed that this confusion on the part of the superior officers was reflected in the performance of the employees. At the one extreme, about one-fourth of the deliverymen believed their work to be a simple routine job and occupied themselves solely with deliveries. At the other extreme, about one-third conceived of their jobs as primarily selling and therefore in addition to their delivery work vigorously solicited further orders. Since the observations of actual solicitations revealed that some 80 per cent of them resulted in additional sales, and that the calls were well received by the customers, the conclusion was drawn that the job of deliverymen was clearly a sales position.

To obtain successful distribution of his commodities or services then, the producer should not solely direct his efforts toward advertising and selling procedures but through job analysis should seek to discover which jobs in actual practice function, or can function, as sales jobs. By this means, a more productive organization should be effected.

The Need for Uniformity of Job and Worker Descriptions.—Systematic job and worker analyses also are necessary in order to provide a common language in the employment field. In different organizations or firms, jobs involving exactly the same tasks may have different titles or names, and contrarily, jobs involving quite different tasks may have the same title. For example, a worker who operates the machine that starches and presses cloth in preparation for dyeing or printing is known variously as a mangle tender, cloth-finishing-machine operator, mangle ranger, or trojan ironer. On the other hand, the job title *mounter* is used in the clothing industry to refer to a laborer who collects bits of waste material, in the furniture-manufacturing industry to a semiskilled worker who attaches carvings and moldings to various parts of furniture, and in the optical industry to a skilled craftsman who assembles and repairs glasses.

In an effort to standardize terminology, the U.S. Employment Service has made job and worker analyses in a number of different occupations,[6] and has published a "Dictionary of Occupational Titles,"[7] which gives definitions and summary specifications for some twenty-nine thousand jobs. This dictionary has had a profound effect on personnel practices. It has provided a basis for a more thorough understanding of the nature of jobs and their interrelationships.

PURPOSES FOR WHICH JOB AND WORKER ANALYSES ARE MADE

The purposes for which job and worker analyses are made are many and varied. Some of the major purposes are briefly discussed in the following paragraphs.

The Development of Measures of Proficiency or Success on the Job.—In order to develop adequate measures for use as indices of success on a job, it is necessary to take into account all the elements of the work involved. It would be inaccurate to describe a rapid typist as a good one if she makes many errors and turns out copy that is not neat. Rapidity of typing is a measure of job success, but it is only one among several possible measures and does not provide a complete description of success. It has already been pointed out that without a systematic job analysis a complete picture of a job cannot be obtained. Consequently the measures used to evaluate the adequacy of the performance of employees should be worked out from a systematically determined set of job specifications.

The Functional Organization of Jobs.—In practically every governmental or industrial organization several persons deal with a given item, each processing it with a given objective. A simple case in point is a machine shop where the work flows from one employee to another. An order is received by a clerk, who turns it over to a shop foreman. The foreman checks the specifications and, in turn, passes the order to a machinist. The latter plans the work, obtains the necessary materials from a stock-room clerk, who previously has received them through the purchasing office, and then proceeds to carry out the job. The finished product is sent to a shipping clerk, and the order, plans, and specifications finally are turned over to a billing clerk.

It is obvious that for effective operation the work must pass through definite channels and that levels or points of authority and responsibility must be definitely established. However, in many firms well-defined routes have not been laid out, and confusion results when the current haphazard organization is faced with an unusual situation, such as the absence of a key man, or a somewhat different type of work. Besides keeping the work running smoothly, a functional organization of the jobs within a firm provides a basis for outlining the sequence of promotions of employees and consequently a basis for a sounder training program.

Job Classification.—The setting up of differential wage scales is a major employment problem in any concern. In an office, for example, the employees will be engaged in a wide variety of activities. Workers will be indexing, filing, typing, handling correspondence, distributing mail, keeping books, operating business machines, making up pay rolls, supervising other workers, etc., and the question of what wage should be paid for each type of work must be answered. The usual solution is to classify the jobs in a hierarchy of categories according to importance, difficulty, degree of supervision required, amount of experience or training necessary, and similar factors. Equal pay, then, is assigned to equal work. Obviously, detailed specifications of the jobs must be available before they can be satisfactorily classified.[8]

The Development of Techniques for Use in the Selection of New Employees.—An adequate description of a job, such as is embodied in a good set of worker qualifications, will be the best source of clues concerning the kinds of questions to be used in the employment interview and the application blank and concerning the types of tests that will probably be most effective in the selection of new employees. A worker analysis then is the first step in the development of selective techniques, since it is the best means of discovering the traits and personal characteristics leading to success or failure on the job.

The Development of More Effective Methods and Procedures of Work.—The degree of success that can be achieved as a result of improving the procedures by means of which a specified task is performed will be a function of the adequacy with which the original procedures have been described. The more complete and exact the description, the clearer will useless parts of the process or parts not of maximal effectiveness stand out. In improving the effectiveness of methods and procedures of work one should begin by obtaining an adequate description of the current processes of work. From a precise account of the movements and operations involved in carrying out the work, points needing improvement may readily be detected.

The Development of More Effective Tools and Equipment.—In the field of the design of tools and equipment, where they should play an important role, job and worker analyses have been almost completely neglected. At the present time, tools and equipment, by and large, are designed by rule-of-thumb methods or a priori analyses. The case of the common heavy screw driver will serve as a good example.

In the few studies made of this type of tool, effectiveness has been evaluated in terms of the amount of force that can be exerted. An adequate analysis of the actual jobs where heavy screw drivers are used probably would reveal that the occasions where screws and bolts are turned by means of a screw driver against a constant strong resistance are relatively few. In many cases a heavy screw driver is used simply because the screw or bolt is a large one and not because there is any great resistance to its turning. In others the initial resistance impeding the turning of the screw or bolt is slight and increases as it is driven home. Analyses of jobs where screw drivers are used would reveal knowledge of the specific characteristics of the different kinds of situations in which screw drivers are needed and thereby provide a much better basis for the design and improvement of this tool. It seems likely that tools evolved by such a process would vary in many unexpected ways from tools found on workbenches today.

The Development of Training Programs.—The two main problems in the setting up of training programs for employees are (1) what to teach and (2) how to teach. Through job and worker analyses, information on these points can be obtained. Such analyses will reveal the skills and knowledge it will be necessary to develop in the training program. With information at hand as to the nature of the different aspects of the work, training for the job can be divided into units arranged in optimal instructional order according to their difficulty and the logical relationships existing between them.[9] In addition, through such analyses the problems of transfer and promotion will be better understood, so that provision in the training program can be made for preparing the workers for change of jobs on the same level or for change of jobs to higher levels requiring more responsibility.

SOURCES OF INFORMATION IN JOB AND WORKER ANALYSES

There are a number of different sources to which the job analyst can turn for information concerning the job. The more sources the analyst draws upon to get a picture of the job, the more valid and complete will be the information he obtains, since information from one source can be checked for dependability and completeness against that obtained from other sources. Commonly used sources are observation of the employees carrying out the work; interviews with employees, their superiors, and individuals whose work brings them in contact with the job in question; responses from any of these three groups on questionnaires; the materials used in the work; published manuals, charts, bulletins, etc., describing the job; and actual performance of the job by the analyst.

Observation of Workers.—The source of information probably most widely used is simple observation of the worker as he is engaged in carrying out the normal activities involved in his job. When these activities are slow enough the analyst can make his observations directly. When they are too rapid to permit accurate personal observation and recording, photographic methods may be employed. For some purposes and for some types of jobs, simple observation of the worker will not yield adequate information. With administrative positions, for example, it is unlikely that from observation alone the analyst can get a clear notion of the activities of the administrator, since so much of his activity is headwork, consisting of making plans, setting policies, etc.

Interviews.—On the face of things it would seem that the person who should know most about the job is the person doing it. Although this may be quite true, there are nevertheless several important difficulties encountered in using the interview of the worker as a source of information. In the first place the success of the interview will be dependent upon the degree of cooperation the analyst is able to obtain from the worker. Obviously, if the workman feels that the study is being made for some purpose that will ultimately work to his disadvantage, he hardly will be willing to give a complete or accurate picture. The use of conversations with employees, then, is intimately connected with the problem of employee motivation and morale. A man who has seen his fellow workmen discharged or who believes that speed-ups result from "efficiency methods" put in by the management will not be helpful to the analyst. Once rapport is established, however, valuable information will be obtained, since most workers take considerable pride in their work and are very willing to discuss matters related to it.

Even if rapport is established, there are still other difficulties with this source of information. The employee might forget to mention certain details of the work, or even though he may be willing to talk he might be unable to put into words a description of certain of the processes. Many manual workers and frequently many office workers have not developed or do not have opportunity to develop any great facility in the use of words for purposes of description. Consequently in the interview they cannot always be expected to give accurate word pictures of what they do on the job.

Interviews of superiors and associates frequently are not particularly valuable as a primary source of information. Only occasionally will such workers have intimate knowledge of the job of another person, even though that person may be working under their direction. Consequently interviews with them should be used chiefly for checks on information derived from other sources.

Questionnaire Responses.—The use of questionnaires with workers or with their superiors or associates involves the same difficulties as are found in the interview. The adequacy of this method, furthermore, depends upon the proper wording of the questions. In an interview, if a question is misinterpreted or not understood, the analyst can repeat it in other words, whereas in a printed questionnaire that is filled out when the analyst is not present such interpretation or amplification cannot be made, and any errors present go undetected.

Materials of Work.—Knowledge of the tools, equipment, machines, printed forms, etc., used on a job, is a useful secondary source of information in job and worker analyses, serving to check the information obtained by other means. Such knowledge also may aid the analyst in formulating questions when the interview or questionnaire method is used. For some purposes, however, knowledge of the materials of work might furnish all the information required.

For example, Jones used this source to prepare a chart for use in apprentice training for patternmakers in the metal trades.[10] What was needed in this situation was some system of checking during the training period in the shop, to determine if each apprentice received training in all aspects of the work. Samples of some one hundred different plans used in patternmaking were studied, and from them the different kinds of materials and tools with which the patternmaker works were listed. On the basis of the information derived, a chart listing all the elements of the work was prepared. During the training of an apprentice the instructor can make sure that each apprentice has had practice on all aspects of the work by referring to the chart on which is checked each element of the work as the apprentice completes it.

Published Manuals, Charts, Bulletins, etc.—For many jobs some of the duties and qualifications are set down by executive order. This is particularly true with a number of government positions, where the specifications are prescribed by law. In addition to these set characteristics, the analyst is often able to obtain from available published sources descriptions that may function as partial job and worker specifications. In most instances, information obtained by this means will again be used chiefly to supplement that obtained from other sources.

Performance of the Job.—In many cases neither observation of the worker performing a given activity nor a description of that activity by a worker gives a complete and accurate conception of the work involved. From the "looks" of an activity one can never get exactly the "feel" of it. The surprise of a nongolfer who finally is induced to "take a swing at the ball" is a common tale. A job or worker analysis will be much more complete and accurate if the analyst has an opportunity actually to try his hand at the job. Skills and abilities not revealed through other sources will become apparent. This source of information concerning jobs has been used in an important fashion in a number of analyses. Link actually took a turn at the workbench when he made an analysis of the job of assembling small-gun parts as a basis for developing employment tests.[11] Similarly, Snow,[12] in an analysis of the job of chauffeur, drove a taxicab, and Viteles,[13] in analyzing the job of streetcar motorman, served a 2 weeks' apprenticeship operating cars.

TECHNIQUES IN JOB ANALYSIS

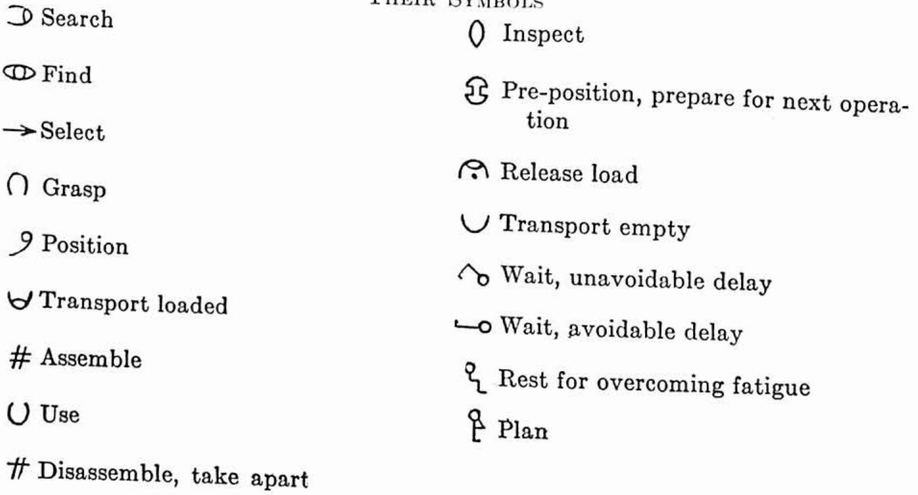
Much of the information sought in job analysis can be obtained without special techniques. Simple observation will reveal whether the work is done inside or outside. Reference to the personnel rolls will tell hours of work, amounts of pay, and the like. The chief problem is to obtain a valid and complete account of the duties the employees are expected to perform and the methods used in carrying them out. The following discussion of job analysis then will be confined to techniques for obtaining such descriptions.

The techniques used in analyzing a job and the manner in which the activities of the workers are described, necessarily will be a function of the type of job being studied. The activities of a factory worker, for example, are almost wholly manual, however complex the job may be. On the other hand the manual activity of a clerical worker or salesperson is less important. The interest in the latter case will be centered primarily on the types of situations with which the employee is confronted, and the procedures he uses in adapting to them, whereas in the former case the interest will be focused primarily on the movements the employee executes in carrying on his work.

The Analysis of Movements.—The movements made by a mail clerk in the simple job of folding bills and inserting them in envelopes will be used to illustrate the problems arising in connection with the analysis of movements, and the techniques developed to study them. The total time required to pick up a bill, fold it, and insert it into an envelope is about 14.25 sec. A job analyst observing a clerk carrying out this job would find it difficult to write down a full description of each of the movements. They are so rapid that by the time a description of the first one or two movements was written down the worker would have finished that unit of work and would have started on another.

One solution to this problem is to have a system of shorthand symbols that the analyst can jot down as he observes the worker in action. Some years ago Gilbreth realized this need and attempted to classify all movements employed in industrial work into seventeen basic types, providing a symbol for each.[14] These elements of movements, called *therbligs*, are shown with their notations in Table 1.

TABLE 1.—GILBRETH'S SEVENTEEN ELEMENTS OF MOVEMENT OR THERBLIGS AND THEIR SYMBOLS



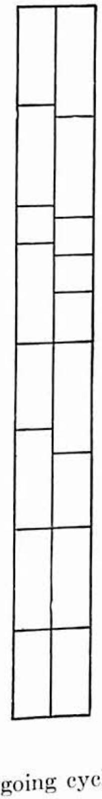
Search
Find
Select
Grasp
Position
Transport loaded
Assemble
Use
Disassemble, take apart
Inspect
Pre-position, prepare for next operation
Release load
Transport empty
Wait, unavoidable delay
Wait, avoidable delay
Rest for overcoming fatigue
Plan

Other symbols or abbreviations are often used, the number of symbols and the particular notations varying greatly with different analysts.

When a very exact description of the movements is desired, a rather detailed system of basic movements such as Gilbreth's is used. For a more generalized description of a worker's movements, four or five basic symbols may suffice.

The analysis of a total sequence of acts into its constituent movements has been termed *motion study*. Some time before Gilbreth's work, Taylor had made studies of the time taken to perform each particular operation in an industrial task. These were called *time studies*.[15] Today the two types of study usually are combined, and the resulting *time-and-motion study* shows not only which movements are being employed but also the time required to perform each of them.

TABLE 2.—ANALYSIS OF THE MOVEMENTS MADE BY A MAIL CLERK IN FOLDING A BILL AND INSERTING IT INTO AN ENVELOPE

Left Hand	Time in ¼ sec.	Right Hand
Hand from pile of folded envelopes to resting position. 2.00 sec. ∪		Select and grasp bill and bring to working position. 2.25 sec.→∩ ⊍
Wait. 2.00 sec. ⌒		Near side of filler folded over and edge matched with edge of far side. 2.00 sec. #
Hand to top of folded bill. 0.75 sec. ∪		Hold bill folded. 0.75 sec. 9
Hold bill folded. 2.00 sec. 9		Hand to edge of fold. 0.75 sec. ∪ Smooth fold. 1.00 sec. #
Reach for envelope. 1.75 sec. ∪		Grasp bill and wait. 2.25 sec. ∩ ⌒
Select, grasp, and carry envelope to working position. 2.00 sec. →∩ ⊍		Carry bill to working position. 1.50 sec. ⊍
Mold envelope for inserting. 2.00 sec. 8		Insert bill in envelope. 2.00 sec. #
Carry filled envelope to dump pile and release. 1.75 sec. ⊍∩		Reach for another bill. 1.75 sec. ∪

Repeat the foregoing cycle of movements

In making a time-and-motion study the job analyst, as he observes the worker, simply notes a therblig on the record sheet every time the worker makes a new movement, and times each of these movements by means of a stop watch. The results of a time-and-motion study are ordinarily presented in a *motion-cycle chart*, such as that shown in Table 2 for the movements involved in the bill-inserting task. The advantages of such a chart over a running verbal description of the movements are obvious. Not only are the individual movements themselves easier to pick out, but also their pattern or sequence and their relative durations can be appreciated more easily.

The speed and variety of movements involved in some jobs is so great that an observer could not possibly record all the worker's movements, much less time them with a stop watch. To overcome this difficulty, motion pictures may be taken of the worker as he carries on his activities. When the film is projected at slow motion, it is a simple task to note the different movements and jot down the corresponding therbligs. By placing a clock near the worker being photographed, the exact time required for each movement can also be determined from the film.

The use of motion pictures is especially valuable, since from them the paths in space through which the worker's hands move can be reconstructed. Depending upon the rapidity of the movements, each second, fourth, etc., frame of the film is projected upon a large piece of paper, and the position of each hand is marked on it by means of a dot. When the positions of the hands have thus been indicated throughout a given cycle of work, the dots are connected. Figure 1 is a chart constructed by this method, showing the movements made by a mail clerk in folding and inserting bills.

Another way of obtaining a record of the paths of the hands is by means of the so-called "cyclegraph." A small electric light is attached to the hands or other moving parts of the worker, and a photographic plate or film is exposed while he works. As the worker moves his hands, a record is made on the plate, which is similar in nature to the picture shown in Fig. 1. In order to time the movements, an interrupter may be introduced into the light circuit. By having the light flash on more suddenly than it flashes off, the record on the photographic plate will be a series of pear-shaped dots from which the direction of the movement can easily be ascertained.

The use of either of the photographic methods discussed above has been termed *micromotion study*, and the resulting chart, a *micromotion chart*. If micromotion charts are made from the photographs of a worker taken by cameras placed at different angles, a three-dimensional reconstruction of the movements can be made by using stiff wires. These wire models of movements involved in carrying out a total act have been found especially useful in teaching new operators, since movements represented in three dimensions are easier to grasp than when they are depicted on a two-dimensional chart, simply described verbally, or actually demonstrated by another worker. The novice has an opportunity to perceive the total sequence of movements at one time and thus can better understand their relationships.

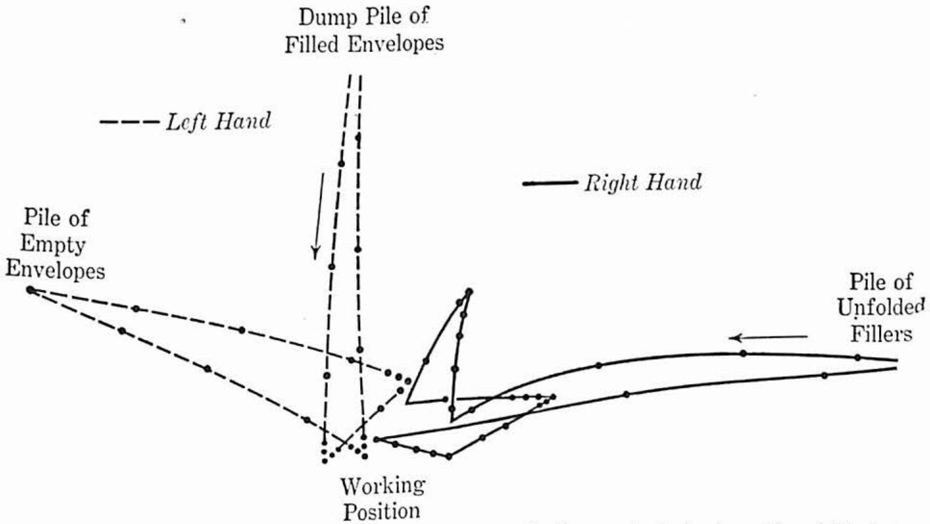


FIG. 1.—Micromotion chart of movements made by a clerk in inserting bills into envelopes.

The Analysis of Situations and Procedures.—Because of the varied nature of the work of nonmanual jobs, it is impossible to set down specific techniques that can be applied to all of them. With such jobs the analyst is interested in knowing the types of situations that confront the worker, and the procedures he follows in dealing with these situations. The problem confronting the analyst is to obtain complete and valid information. When dealing with positions in a highly organized occupation, it will be a relatively easy task to obtain satisfactory information and to make sure that it is complete, since the lines of work are already laid down in definite channels, sequences, and groupings. On the other hand, when the analyst is confronted with the opposite situation and must deal with a job whose duties are not clearly prescribed, the task will be extremely difficult, since there will be no obvious points of departure for making the analysis, nor any organization or sequences to follow in the analysis.

A job analysis of the police service made by Boswick[16] is an example of an analysis made in a highly organized occupation, while that of public sanitarians, made by Loye,[17] will exemplify the problems facing the analyst in an occupation that had been subject to little or no systematization. In the police service, Boswick found the jobs already classified into divisions, such as the patrol division, traffic division, and crime-prevention division. Information also was available concerning the types of assignments given to the men in each division. Thus in the traffic division the men were assigned to intersectional and traffic control, parking control, motorcycle control, etc. All that remained was to discover and list the duties and activities under each assignment. This was done through observation and interviews.

Compared with this relatively simple situation, the one confronting Loye was extremely difficult and complex. She found that the duties of public sanitarians varied markedly from one health department to another. The types of situations dealt with by sanitarians, and the procedures followed in dealing with them, showed very few factors in common. Under such conditions it was difficult indeed to set up any curriculum or training for sanitarians, or to classify adequately the position in any family of jobs or hierarchical grouping for salary scaling.

Loye's task, then, was to discover *all* the situations with which *any* sanitarian is called upon to deal. To do this she observed sanitarians carrying out their duties and interviewed people engaged in public health work and in allied fields. Having accumulated all the information she could her next task was to organize the material.

The first step in organization was to classify the general fields in which the sanitarian works, such as disease control, water supply, and sewage disposal. The next step was to list the specific situations with which the sanitarian was confronted in each of these fields, and the particular duties he carried out in connection with each. For example, in the field of food sanitation the sanitarian inspects, among other things, bottling plants. Loye was able to discern nine different situations in bottling plants with which the sanitarian has to deal. One of these, the inspection of transportation and storage provisions, was found to involve the following duties: the determination of the sanitary conditions of bottles, bins, vats, and other containers; the determination of provisions for ventilation, storage of covers and stoppers, and storage in separate rooms of the different materials used in the manufacture of the finished product; and the determination of provisions for using noncorrosive materials for water tanks. Her final specifications of the job of sanitarian, then, probably do not describe the work carried on by any certain sanitarian but rather form a classification of the duties that any sanitarian may be expected to carry out.

Charter and Whitley's study of secretaries is especially interesting from the point of view of the methodology used in obtaining a complete and valid list of the activities associated with this job.[18] As was previously pointed out, these investigators were not satisfied with their own efforts to list all the different secretarial duties. Consequently they prepared a daily schedule chart, which was filled out by a group of cooperating secretaries as they actually carried out their work. This procedure assured the completeness of the list, inasmuch as the opportunity to forget details was virtually eliminated, and it

TABLE 3.—TWENTY-FIVE DUTIES MOST FREQUENTLY MENTIONED BY SECRETARIES

Secretaries Mentioning, Per Cent	Duty
96	Typewrite letters
95	Answer telephone
93	Dictation of letters
93	Transcription of letters
93	Use of telephone, local
90	Address letters, packages, etc.
89	Insert letters into envelopes
88	Fold letters
86	Order supplies
86	Place telephone memoranda where employer will see them
84	Compose letters
84	Send telegrams
82	Seal mail
81	Sign mail
81	Clean and oil typewriter
79	Mark, attach, or get enclosures
79	Get material from files
79	Stamp letters, packages, etc.
78	File letters
77	Use of telephone, long distance
75	Receive telegrams
75	Type telegrams
74	Read incoming mail
73	Transcribe telegrams
72	Meet callers

also enhanced the validity, since the secretaries wrote down the duties they *actually* performed and not those they *thought* they did or should do.

The 871 different duties obtained by this method were prepared in the form of a check-list questionnaire, and responses were obtained from 715 secretaries by having each one check those duties on the list that were included in her particular job. The average number of duties checked was 132; the fewest number being reported by any secretary was 15, and the largest, 479. In Table 3 the 25 most frequently reported duties are listed, together with the percentage of secretaries reporting doing them. It will be noted that only 22 of the 871 duties, or 3 per cent, were performed by three-quarters or more of the secretaries. From this study it can be concluded that the position of secretary is not one with clearly or universally prescribed duties. The duties a secretary is called upon to perform appear to be a function of the particular job situation in which she finds herself, since a classification of the secretaries according to the occupation of their employers revealed a marked difference in duties from one group to another.

THE PROBLEM OF WORKERS ANALYSIS

Estimated versus Actual Worker Characteristics.—There are two quite different approaches to the problem of worker analysis. A given job may be described in terms of the skills, abilities, and other characteristics that it is believed the worker must have in order to perform the job successfully, or it may be described in terms of the skills, abilities, and other characteristics that are possessed by workers actually employed on the job. The first type of description may be said to be concerned with *estimated worker characteristics*, since the personal characteristics deemed necessary in the worker are estimated from the analyst's knowledge of the nature of the work or from similar knowledge possessed by others. The job specifications, or similar information obtained by unsystematic means, form the basis of the estimated worker characteristics. The second type of description may be said to be concerned with *actual worker characteristics*, since with this approach an attempt is made to describe the personal characteristics of individuals who are actually working on the job.

The estimated and actual worker characteristics may not necessarily be the same. For example, the machines in a factory may be designed to be operated for optimal effectiveness by right-handed persons, whereas one-third of the employees in the plant might be left-handed. From the job specifications it would be inferred that right-handedness was a necessary qualification, whereas an objective description of the distribution of handedness among the workers would lead to the conclusion that right-handedness is not a required characteristic. Similarly a particular selling job might not require knowledge of mathematics, but, if the salesmen were graduate engineers, they might well bring such knowledge into play. The worker specifications in this job would vary somewhat depending upon whether estimated or actual worker characteristics were used. Thus a trait or other characteristic which is rated as important by the one method of analysis may be rated as unimportant by the other.

Early Approaches to Worker Analysis.—In the earliest worker analyses, the attempt was made simply to list those traits, abilities, and skills which appeared to be important. On the basis of the job specifications or other sources of information, the analyst sought to set down those characteristics which in his judgment were important for the job under consideration. Such lists were very likely to suffer from the use of vague and abstract terms that rendered them useless for any practical purposes.[19] For instance it might be said that the job of machinist requires manual dexterity, judgment, concentration, and ability to plan. Impressive as this list of job requirements may seem, it is obvious that the same four traits also could be used to describe the requirements of a typist. This deficiency can be remedied to a considerable extent by using specific rather than generalized traits, and by a careful definition of terms. Specifying the traits with careful definitive descriptions and exemplifying them with samples of actual behavior would go far toward improving the results.

A study by Charters and Whitley may be cited as an example of a worker analysis performed with the objective of discovering the traits essential for a particular job, viz., that of secretary.[20] These investigators interviewed 28 executives, asking them questions such as the following: "When hiring a secretary, what are the qualities in which you are especially interested?" "Who was the best secretary you ever had? Now tell me in what respects she differed from the others you had?" "Have you ever discharged a secretary? Why?" By this means the actual performance of secretaries formed the basis of the respondents' answers. Thus, vague, abstract, and presumed qualifications tended to be avoided.

A large number of different trait names were used by the executives, which were classified by the investigators under 47 headings. Each of these 47 different trait categories was defined by actual samples of the behavior of secretaries. The ten most frequently mentioned of the 47 trait categories are given in Table 4, together with the percentage of executives mentioning each. It will be noted that only 4 of the 47 trait groups, or 9 per cent, were mentioned by three-quarters or more of the persons interviewed. This confirms the findings from the job analysis that the position of secretary is not a clearly defined one.

TABLE 4.—THE TEN MOST FREQUENTLY MENTIONED TRAITS OF SUCCESSFUL SECRETARIES

Executives Mentioning, Per Cent	Trait
86	Accuracy
82	Responsibleness
75	Dependability
75	Intelligence
71	Courtesy
71	Initiative
68	Tact
64	Personal pleasantness
64	Personal appearance

Redefinition of Worker Analysis.—It has been pointed out that worker analyses, which result in a list of traits that are presumed to be essential, are very apt to suffer from the use of trait names so general in connotation as to be of little value. The procedure of simply listing essential traits is inadequate in still another respect. For most purposes it is not sufficient to say that a given trait is or is not important. Rather it is necessary to know the degree to which the trait is important.

A watchmaker, an assembler of electrical equipment, and a cherry pitter all need to have more than an ordinary amount of finger dexterity, but certainly not the same amount. It is obvious from the nature of the work that the watchmaker needs more finger dexterity than either of the other two workers, and the assembler requires more than the cherry pitter. Two or more jobs might not differ in terms of the particular traits, abilities, and skills that are important, but they might differ radically in terms of the degree of importance assigned to these characteristics. It is necessary, therefore, for worker analysis to provide estimates of the degree of importance of each of the traits deemed necessary.

The foregoing discussion now permits a more exact definition of worker analysis, one developed from the point of view of estimated characteristics. Instead of stating the purpose in general terms, as the means of providing information concerning the traits deemed necessary in the worker, it can be more carefully stated as providing information relative to the amount of each of a number of traits in the worker that are considered essential in order that he successfully carry out the job. The analyst seeks to determine the fewest number of traits, abilities, and skills that are required by the job, and the least amount of each of these that the worker needs to have. In other words the object is to discover the *minimum qualifications* necessary for satisfactory accomplishment of the work.

CRITERIA FOR THE EVALUATION OF TECHNIQUES OF WORKER ANALYSIS

This more explicit definition of worker analysis now permits us to set up criteria by means of which procedures and techniques employed in worker analysis can be evaluated. The factors that should be considered in such an evaluation are (1) the degree of agreement among analysts relative to the minimum amount of each of a variety of traits, abilities, and skills necessary, (2) the degree to which ratings of importance of various worker characteristics are independent, and (3) the degree to which the analysts' judgments of the relative importance of various traits, abilities, and skills correspond to their actual importance in terms of the demands of the job. Each of these criteria will be discussed below, and illustrations of the manner in which each may be applied will be considered.

Agreement among Analysts.—One index of the adequacy of any quantitative technique is the reliability of the final measurements. In worker analysis the extent of agreement among analysts concerning the minimum amount of each trait considered essential is an important means of evaluating the adequacy of the technique used. In instances of disagreement the error may be due to inadequacy of the basic data on which the analysts' judgments are based, to a lack of understanding of the worker characteristic being considered, or to a deficiency in the scale on which degree of importance is recorded. To be sure, disagreement may be due to lack of ability or training on the part of the analysts or to the nebulous character of the job being analyzed. However, in any study, incapable or untrained personnel should not be utilized, and in poorly defined jobs any disagreement can easily be understood and indeed is to be considered as an accurate description of the true state of affairs. Assuming that the analysts are of high caliber and that specific, well-defined jobs are being studied, then the degree of agreement among analysts is an important means of evaluating a particular technique.

Perfect agreement in all worker characteristics, even with highly selected analysts, certainly cannot be expected. The usual procedure in cases of disagreement is to invite open discussion among the analysts. By this means, the causes of disagreement can be discovered and resolved. Although discussions of this kind will bring to light such difficulties as the varying character of the job and the insufficiency of the job information, they will also point out deficiencies in the procedures used in the worker analysis. On the basis of the discussions the procedures can be improved. In Table 5 are given the distributions of ratings made by a group of job analysts of the importance of two worker characteristics for four jobs. It is apparent from this table that there was far from perfect agreement among the analysts.[21]

TABLE 5.—PERCENTAGES OF 87 JOB ANALYSTS ASSIGNING DEGREES OF IMPORTANCE OF TWO WORKER CHARACTERISTICS FOR FOUR JOBS

Job and characteristic	Degree of characteristic required by the job		
	Amount possessed by the large bulk of the population, per cent	Amount more than that possessed by the bulk of the population, per cent	An exceedingly high amount, per cent
Ability to work rapidly for long periods of time:			
Waitress (counter girl)	6	60	34
Typist (copy girl)	8	49	43
Gasoline-station operator	70	28	2
Theater cashier	33	57	10
Finger dexterity:			
Waitress (counter girl)	84	16	0
Typist (copy girl)	1	57	42
Gasoline-station operator	91	9	0
Theater cashier	31	67	2

As is frequently found, the degree of agreement varies with the worker characteristic being judged and the job being considered. In the discussions among the analysts, difficulties with the definitions of the traits were encountered. In the case of the characteristic "ability to work for long periods of time," the question was raised as to how much time is to be considered a long period. Also a further question raised the problem of whether the work had to remain the same pattern of activity, or whether shifts in pattern are to be considered interruptions and, therefore the work is to be considered as not continuous. In the case of finger dexterity, for example, does the characteristic considered include both the manipulation of small objects and "fingering"?

Further questions brought out inadequacies in the scale, such as what degree of a characteristic is to be considered "exceedingly high," and how large is "the bulk of the population" to be considered? Thus, from the discussion among the analysts, certain deficiencies inherent in the technique became apparent from their disagreement. Correction of these inadequacies undoubtedly would produce greater agreement.

Independence of Ratings of Different Characteristics.—There is little point in having worker analysts evaluate jobs in terms of a variety of characteristics if the analysts are unable to discriminate between these characteristics. Although it may be true that a particular job requires strength of hands but not strength of arms, the analyst undoubtedly will rate both types as being important if he is unable to judge reliably which muscle groups are being used. In such a case the analyst would check both arm and hand strength as being important in any job, where either one or the other was used. Thus the ratings of importance on strength of hands and strength of arms would tend to be the same for any given job. For one job both characteristics would be given a rating of "no importance," for another job both would be given a rating of "some importance," and for a third job both would be given a rating of "paramount importance." If a number of jobs were analyzed, the coefficient of correlation between ratings on these two characteristics would be 1.00. Under such circumstances, ratings of importance on the single trait "strength of hands and arms" would give the same description as ratings on either strength of hands or strength of arms given separately.

In some cases the lack of discriminability will be due to inability of the analysts, through sheer human obtuseness, to differentiate traits that are truly different. In this event the remedy is a more careful selection and training of analysts. Even skilled analysts, however, will have difficulty in differentiating between worker characteristics if they are poorly defined or if they represent traits that are too generalized. The less exactly the traits are defined, the less basis will there be for the analysts to consider them as being independent. The more generalized the traits are, the more meanings they will have in common, and as a consequence the more likely they are to be given the same ratings of importance for any particular job.

In Table 6 are given the intercorrelations between ratings of importance of four worker characteristics, for 60 jobs, all of which were of a semiskilled mechanical nature. These ratings were the estimations of five experienced analysts, which were pooled after discussion and resolution of disagreements. Although three of the characteristics—stooping, crawling, and twisting—are quite independent of each other in terms of the coefficients of correlation between the ratings of importance assigned to them, the ratings on the characteristic "crouching" are fairly closely related to the other three. It would seem that the latter characteristic, at least in the minds of the analysts, is a more general trait than the other three. Stooping, crawling, and twisting were probably considered as being elements of the more generalized trait of crouching. Thus it is likely that not much pertinent information about these jobs would have been lost if the worker characteristic of crouching had been eliminated.

TABLE 6.—INTERCORRELATIONS AMONG RATINGS OF IMPORTANCE OF FOUR WORKER CHARACTERISTICS FOR 60 SEMISKILLED MECHANICAL JOBS

	Crouching	Stooping	Crawling	Twisting
Crouching	....	0.72	0.50	0.67
Stooping	....	....	0.25	0.05
Crawling	....	....	....	0.05

Certain limitations should be noted in applying this criterion—the magnitude of interrelationships among ratings of importance of worker characteristics—to the evaluation of a particular procedure of worker analysis. High coefficients of correlation between ratings of importance of two or more characteristics may be obtained even when there is no confusion between them on the part of the analysts, and when the traits these characteristics represent are actually independent. The jobs selected for study may be of such a nature that certain characteristics necessarily will be associated in the final worker specifications.

By way of illustration, suppose worker analyses were made of the following four jobs: comptometer operator, billing-machine operator, stock clerk, and receptionist. Both the characteristics of arithmetic ability and finger dexterity would be rated important for the first two jobs and unimportant for the last two. The analyst obviously would not confuse two such disparate traits, and yet for these four jobs the coefficient of correlation between ratings on the two characteristics would be 1.00. In such clear-cut cases, the basis of the high correlations between ratings can easily be understood. In cases where more subtle differences occur, an explanation of high correlations will be difficult to discover.

With a homogeneous group of jobs, most of which will have similar worker requirements, high coefficients of correlation between ratings of importance would not be expected and, therefore, can be viewed with suspicion. When a wide variety of jobs is being studied, such coefficients may well be expected and cannot be considered as necessarily indicative of deficiencies in the procedure for worker analysis. In Fig. 2 is given the distribution of coefficients of correlation between ratings of importance on nine worker characteristics made by one experienced analyst for 50 different jobs. These jobs were highly varied, ranging from professional to unskilled. The characteristics considered were dexterity of fingers, arms, and hands, and strength of hands, arms, back, and legs. It will be observed in the figure that the coefficients of correlation among the various characteristics judged are generally high, 50 per cent of the coefficients being 0.80 or above.

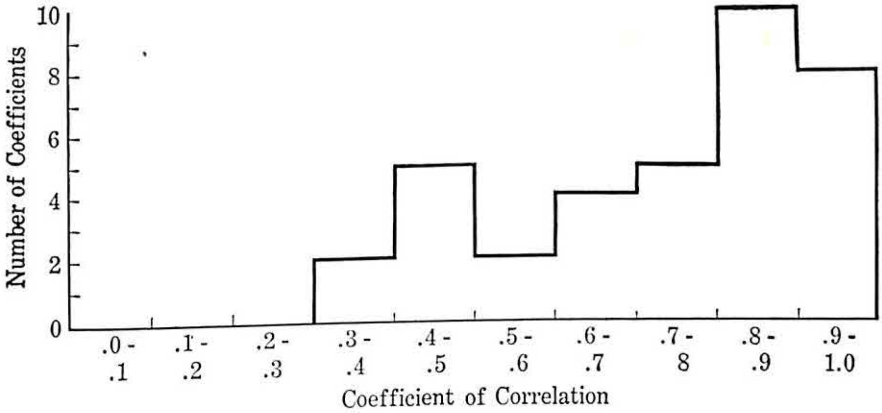


FIG. 2.—Distribution of coefficients of correlation between ratings of importance of 9 worker characteristics for 50 jobs.

Correspondence of Estimated Importance of Characteristics with Actual Importance.—If the traits that in actual fact are important for successful performance of a job are not so noted, then the worker analysis obviously is inadequate. Similarly, if the degree of importance of any characteristic is either underestimated or overestimated, the analysis cannot be considered a satisfactory one. Essentially the problem here is one of validity. Do the estimated requirements of the job correspond to the actual requirements?

From a practical point of view this kind of evaluation is most difficult to make and in some cases may be impossible, since there is no final authority on the demands of the job to which the investigators can resort. Indeed, if there were, these sources would be used rather than estimations made by worker analysts. For the most part the best that can be done at the present time is to resort to indirect measures of the validity of the analysts' judgments. Since these measures will be indirect, they should be interpreted with considerable caution.

In a worker analysis made for the purpose of developing selection tests, for example, the importance of the various traits, as estimated by the analysts, can be compared with the coefficients of correlation between scores on the tests used to measure these traits and success on the job, *i.e.*, the validity coefficients of the tests. If tests for those characteristics considered very important for the job have high validity coefficients, and those for characteristics considered only fairly important have lower validity coefficients, then the correspondence between the estimated requirements of the job and the validity coefficients of the tests strongly suggests that the worker-analysis technique used was satisfactory.

For purposes of illustration, Table 7 shows a comparison of the relative importance of several characteristics deemed necessary for the job of inspector-packer and the validity coefficients of tests selected as probably good measures of these characteristics. For the five traits considered to be of some importance, there appears to be a rough relationship between estimated degree of importance and the validity coefficients of the tests employed to measure them. In addition, for five tests measuring traits believed to be of negligible importance for the job, the average validity coefficient was quite low. The results of this particular investigation suggest that the technique of worker analysis employed yielded satisfactory estimates of the degree of importance of the various traits considered.

Obviously, if either the tests or the measures of proficiency on the job are inadequate, the evaluation cannot be considered a satisfactory one. For example, suppose manual dexterity of the sort involved in well-coordinated movements of the wrist is important for the job and is so noted by the analyst. If the test designed to measure manual dexterity involved rapid movements of the hands but little coordination of wrist movements, a low correlation between test scores and success on the job would not be surprising. Similarly, if success on such a job was measured in terms of superiors' ratings, and these ratings did not take into sufficient account production records, even an adequate test of the trait would show little validity.

Certain worker analyses are carried out primarily in order to get information concerning the physical demands of various jobs.[22] The aim of such analyses is to provide information about the jobs that will be useful in the placement of physically handicapped persons.

TABLE 7.—THE IMPORTANCE OF WORKER CHARACTERISTICS FOR THE JOB OF INSPECTOR-PACKER AS JUDGED BY A WORKER ANALYST IN RELATION TO THE VALIDITY COEFFICIENT OF TESTS SELECTED TO MEASURE THESE CHARACTERISTICS

Worker characteristic	Rank in importance of characteristic as estimated by analyst	Validity coefficient		Test selected to measure the characteristic
		Rank	r	
Finger dexterity..........	1	2	0.50	Peg board
Perception of differences in details................	2	3	0.42	Name and number comparison
Perception of size and form.	3	1	0.57	Spatial relations
Eye-hand coordination....	4	4	0.40	Tapping and dotting
Dexterity of hands and arms..................	5	5	0.24	Block placing
Average validity coefficient of five tests measuring traits considered to be of negligible importance...	..	..	0.13	

Knowing the physical demands of jobs on the one hand, and an individual's physical capacities on the other, presumably makes possible a more effective job placement of the individual. If the procedure of analysis gives accurate and complete information, then a drop in sickness rate, accident rate, and labor turnover should be expected from the improved placement of the workers.

QUANTITATIVE TECHNIQUES IN WORKER ANALYSIS

A number of different techniques for worker analysis that yield quantitative estimates of the requirements of jobs have been developed. Very few of them, however, have been completely described in the professional literature, and therefore little is known about them. We shall describe two techniques that have apparently been successful, but owing to lack of sufficient information they cannot be critically evaluated in terms of the criteria set forth above.

Viteles' Technique.—One of the earliest attacks on the problem of worker analysis from the quantitative point of view was made by Viteles.[23] He listed and defined 32 different traits that he considered important and that might be used to describe workers on most jobs. These traits, shown in Table 8, are to be rated for a given job by the analyst on a five-point scale as follows:

1. Negligible
2. Barely significant
3. Significant
4. Of great importance
5. Of utmost importance

Below are two illustrations of the manner in which the traits were defined by Viteles:

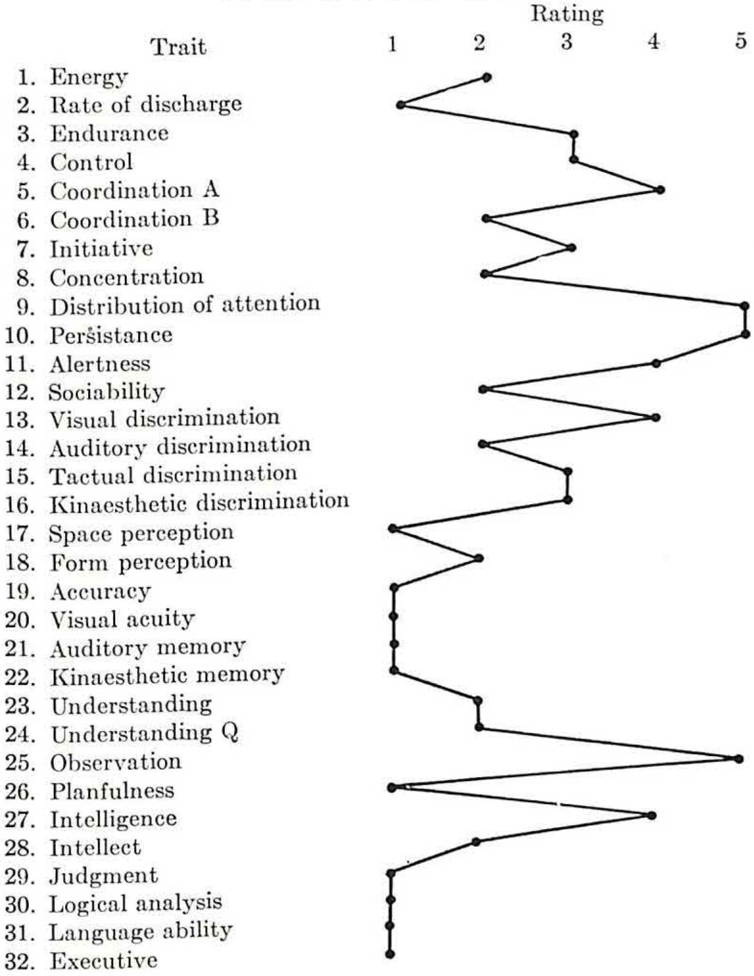
Rate of Discharge: By this is meant the *speed* with which energy must be expended on the job. In some jobs, such as that of longshoreman, much energy is needed, but it is discharged slowly, while in others much energy must be expended with great speed, as in emergency work on overhead lines. On the other hand there are many jobs where energy demand is low, and energy may be expended at either high or low speed.

Coordination B: This refers to the harmonious combination of visual and muscular functions on the job. It is important, for example, in such jobs as telephone operating, in which the operator is required to place a plug into a hole of small diameter, the location of which is perceived through the eye. At the other extreme is that of loading crates or bales into a boxcar, in which coordination B is a negligible factor.

The analysis of the job of quiller in the textile industry made by Cades will serve as an example of Viteles' method.[24] The ratings of each of the traits are usually presented graphically in what is termed a *job psychograph,* as in Table 8. Those traits considered most essential are clearly revealed by peaks in the curve at the high ratings. Such traits are called *keystone* traits, since they characterize a job and distinguish it from other jobs.[25]

Employment Service Technique.—Viteles' technique has been revised by the U.S. Employment Service.[26] The general principle of rating the minimum amounts of each of a number of traits is the same as that used by Viteles, but the manner in which the traits are rated is somewhat different. A three-step scale of unequal intervals is used, rather than a five-step scale of equal intervals. The ratings A, B, and C are defined as follows:

TABLE 8.—JOB PSYCHOGRAPH, USING VITELES' METHOD, OF THE JOB OF QUILLER IN THE TEXTILE INDUSTRY



A indicates that a high degree of the trait in question is demanded by the job, an amount of the trait such as is possessed by only 2 per cent of the general employed population.

B indicates that the workman should have more than an average amount of the trait, not as much as is indicated by a rating of A, but more than is indicated by a rating of C; an amount such as is possessed by the next 28 per cent of the general employed population.

C indicates that an amount of the trait such as is possessed by the lowest 70 per cent of the general employed population is adequate for the job.

In making his ratings the analyst is instructed to think of the general employed population rather than workers on the particular job in question. The analyst is further instructed that when in doubt as to whether a job warrants an A or B rating, or a B or C rating, he is to check it as B, so that important traits will not be overlooked. Forty-five different traits were rated in this fashion. These traits are listed in Table 9.

As in Viteles' method the traits being rated are carefully defined. The following description of finger dexterity is an example:

Definition: ability to manipulate small objects by rapid and/or accurate movements of the fingers.

Illustration: cherry pitter (canning and preserving).

Summary of duties: dumps cherries on work table and *removes pits* from cherries with a small scoop. Places pitted cherries in pans, segregating into three grades.

Job elements that justify rating of B: holding cherry in one hand and pitting tool in the other hand, removes pits from cherries. This important operation requires a high degree of finger dexterity.

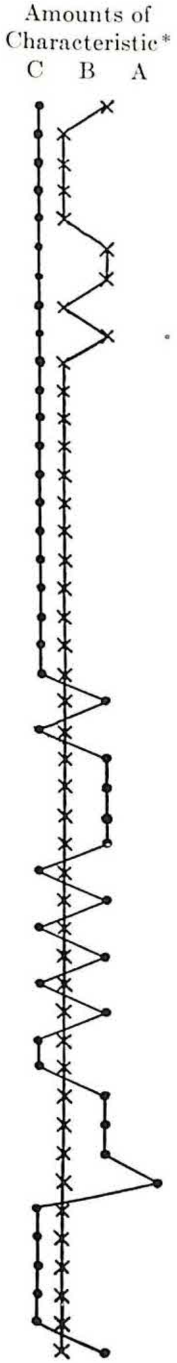
Other jobs requiring an A or B amount of dexterity of fingers are the following: key-actuated-calculator operator, card-punch-machine operator, hand embroiderer, typesetter, and automatic-tea-packaging line attendant.

The authors report that the agreement between different analysts' ratings of the same job is high enough to justify the use of this method. The analyses of the jobs of cherry pitter and airport clerk, made with this technique, are shown in Table 9.

PROBLEMS AND TECHNIQUES IN THE STUDY OF ACTUAL WORKER CHARACTERISTICS

Link was the first to suggest that the traits required in workers on a given job could be described in terms of their performance on a variety of psychological tests.[27] The basic idea was to administer a group of tests to workers on a given job and then to describe the psychological qualifications for the job in terms of the scores earned. In this way a job psychograph could be constructed, substituting actual test scores for subjective estimates. The methodological problems in this approach have been refined by the Employment Stabilization Research Institute of the University of Minnesota, and a number of such analyses have been made by their workers.[28] These investigators standardized a number of psychological tests by administering them to a representative cross section of the general employed population.[29] The same tests were then given to workers in a number of different jobs, and the average scores made by them were calculated. Typical

TABLE 9.—JOB PSYCHOGRAPHS OF CHERRY PITTER AND AIRPORT CLERK MADE BY THE U.S. EMPLOYMENT SERVICE



Characteristics Required of Worker

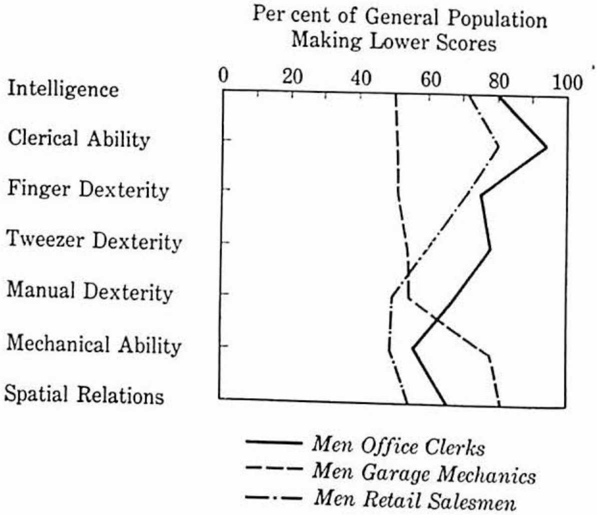
1. Work rapidly for long periods
2. Strength of hands
3. Strength of arms
4. Strength of back
5. Strength of legs
6. Dexterity of fingers
7. Dexterity of hands and arms
8. Dexterity of foot and leg
9. Eye-hand coordination
10. Foot-hand-eye coordination
11. Coordination of independent movements of both hands
12. Estimate size of objects
13. Estimate quantity of objects
14. Perceive form of objects
15. Estimate speed of moving objects
16. Keenness of vision
17. Keenness of hearing
18. Sense of smell
19. Sense of taste
20. Touch discrimination
21. "Muscular" discrimination
22. Memory for details (things)
23. Memory for ideas (abstract)
24. Memory for oral directions
25. Memory for written directions
26. Arithmetic computation
27. Intelligence
28. Adaptability
29. Ability to make decisions
30. Ability to plan
31. Initiative
32. Understanding of mechanical devices
33. Attention to many items
34. Oral expression
35. Skill in written expression
36. Tact in dealing with people
37. Memory of names and persons
38. Personal appearance
39. Concentration amidst distractions
40. Emotional stability
41. Work under hazardous conditions
42. Estimate quality of objects
43. Work under unpleasant conditions
44. Color discrimination
45. Ability to meet and deal with public

*** Airport clerk, ●—● Cherry pitter, ×—×**

results obtained from three groups of workers are shown in Table 10.[30]

Paterson has pointed out that the use of tests in this manner to describe the worker characteristics involves the following three postulates: the existence of unique traits, the existence of tests that validly measure each of these unique traits, and that these traits have differential occupational significance.[31] Evidence relative to each of these postulates will be considered in the following paragraphs.

TABLE 10.—AVERAGE SCORES ON PSYCHOLOGICAL TESTS MADE BY DIFFERENT OCCUPATIONAL GROUPS



Postulate 1. The Existence of Unique Traits.—If there were just one general factor underlying all mental traits, then one test could be used to describe any job, since a person standing high in any one kind of performance would stand equally high in all others. Unless the tests employed measure unique traits, *i.e.*, separate and independent traits, then one job cannot be differentiated from another by means of differently shaped job-test profiles. In other words, jobs could not be differentiated in terms of their differing requirements for superiority in various traits.

The best evidence from the study of individual differences appears to bear out the theory of unique traits. If a number of tests varying widely from one another in nature and content are administered to a group of individuals, the coefficients of correlation between scores on the tests, on the average, will be found not to differ greatly from zero. This indicates that individual differences on the tests cannot be attributed to a single general factor or ability but rather must be explained on the basis of a number of separate or distinct factors, abilities, or traits.

Postulate 2. There Are Tests Available That Validly Measure Each of These Unique Traits.—Although the concept of unique traits is generally accepted, it cannot be said that there is good agreement as to what these traits are. Consequently there are no tests available known to measure validly each of many traits. It can be argued, however, that it is not necessary to include measures of all independent traits in the battery of tests, but only a varied sample of tests that are relatively uncorrelated. This, presumably, is the basis on which the Employment Stabilization Institute workers operated. Nevertheless, since these investigators have not demonstrated that the tests they use are relatively independent, as indicated by low intercorrelations among them calculated from the scores made by a representative sample of the general employed population, the results of their studies can be accepted only as tentative.

Postulate 3. Differential Occupational Significance of the Unique Traits.—Link pointed out some time ago that tests on which workers on a given job are superior should also show a correlation with success on that job.[32] If this were not true, then an occupational pattern of

TABLE 11.—DIFFERENTIATION OF WORKERS ON VARIOUS JOBS BY TESTS SHOWING AN INSIGNIFICANT CORRELATION WITH JOB SUCCESS

Job	N	Validity coefficient	Mean score	Standard deviation
O'Rourke Vocabulary Test				
Card-punch-machine operator	113	0.04	69	8
Bookkeeping-machine operator	52	−0.07	59	16
Hand transcriber	53	0.01	55	18
Department-store salesperson	153	0.01	48	18
Cafeteria floor girl	48	0.04	42	10
Power-sewing-machine operator	46	−0.07	25	14
Minnesota Clerical Test—Number Comparison				
Bookkeeping-machine operator	52	−0.09	154	21
Calculating-machine operator	37	0.10	140	16
Inspector-wrapper	41	0.02	110	21
Cafeteria floor girl	48	0.00	102	21
Hand transcriber	53	0.08	95	26

test scores would be meaningless in terms of ability associated with successful work on that job. The high scores earned by a particular job group would have to be explained on the basis of other factors.

One factor, for example, that may cause workers on a given job to have high scores on certain tests is differential sampling. Individuals with certain patterns of traits may seek work on a given job, rather than other jobs, not because their abilities are particularly suited to it but because of social pressure, custom, convenience, availability, and the like. Dvorak has offered certain evidence in support of the validity of this assumption.[33] With several jobs she has shown that workers varying in success on the same job show similar patterns of test scores, but the poorer workers earn lower scores than the better ones.

There are many cases, however, where workers on different jobs make widely different test scores, but the scores, nevertheless, show little or no relationship to success on the job. Examples of this drawn from Stead and Shartle are shown in Table 11.[34] At present, it cannot be concluded that this postulate has been demonstrated to have any general validity.

Conclusions Relative to the Study of Actual Worker Characteristics.—Although highly suggestive as a method of worker analysis, the study of actual characteristics of workers cannot be considered to be very fruitful in view of the doubtful validity of the postulates on which it rests. In addition, so little work has been done in this area that many of the basic problems have not been clearly defined. For example, the question may be raised relative to the point to be used in setting up minimum qualifications. Shall it be the average or the lowest score made by any worker considered "satisfactory," or some other minimal value? These are matters that have not been given sufficient thought up to the present time. It is possible that as further knowledge is gained concerning the basic nature of, and interrelationships among, abilities the problems will become clearer, and this approach to worker analysis will become more valuable.

OCCUPATIONAL ANALYSIS

The study of the relationships between jobs is still in an early stage of development. Until very recently the grouping of jobs into occupations was done on a logical, rather than on an empirical, basis. A typical logical classification is the following:

Professional and managerial
Semiprofessional, minor business, and supervisory
Clerical
Sales
Skilled
Semiskilled
Unskilled

Although such logical classifications have been found to be useful in the rough organization of data relative to occupational differences, such as occupational differences in intelligence test scores, they contribute very little information concerning the possible interchangeability of specific jobs. For example, a typist and a bookkeeper would both be classified in the clerical group, in spite of the fact that the nature of the work connected with each, and the skills, abilities, and knowledge required by them, are considerably different.

Two major attempts, using quite different methods, have been made to classify jobs into occupations on an empirical rather than a logical basis, one by the investigators associated with the Employment Stabilization Research Institute of the University of Minnesota, and the other by the U.S. Employment Service. The work of the Minnesota group has been partially described in previous sections of this chapter.[35] These investigators have been interested only in the worker specifications and have sought to measure them objectively by the use of standardized psychological tests. Briefly the method consists in administering a battery of standardized tests to groups of workers on various jobs and plotting the average scores on a psychograph as in Table 10. Although the Minnesota group uses these psychographs primarily as analyses of specific jobs and does not attempt a thorough occupational grouping or analysis, it follows that jobs showing similar patterns in their psychographs belong together in the same occupational group, while those showing dissimilar psychographs belong in different categories. In Table 10, for example, it can be seen that the jobs of office clerk and retail salesman show a closer correspondence in pattern of test scores than does either one of them with the job of garage mechanic.

The value of this technique for the grouping of jobs into occupations will depend upon the adequacy of the postulates on which it rests. Those postulates are discussed in an earlier section dealing with techniques in studying actual worker characteristics. It was concluded there that insufficient evidence has been advanced to establish the validity of these postulates. Consequently it would be erroneous at the present time to put great emphasis on the use of this method in occupational analysis.

The U.S. Employment Service considers both the job and worker specifications in classifying jobs into occupations.[36] The investigators in the Employment Service point out that insofar as the interchangeability of jobs is concerned, job specifications constitute the salient features for some jobs, whereas for others the worker specifications are the important consideration. No single criterion, then, is used in determining a job classification. The emphasis, however, is on the worker specifications, so that jobs requiring the same experience, abilities, and methods of work are classified together. In making the analyses, the analysts connected with the Employment Service estimated the minimum qualifications on the three-step scale described earlier in this chapter. However, duties, types of machines used, nature of the materials worked with, nature of the articles produced, and working conditions also were taken into consideration.

Some twenty-nine thousand job titles are defined in the "Dictionary of Occupational Titles," and each is assigned either a five- or six-digit code number.[37] The jobs are classified by means of their code numbers into seven major occupational groups, each of which, in turn, is divided and subdivided into smaller groupings with increasingly greater similarity. The code numbers run from 0–01.10 for the job of cost accountant to 9–98.91 for grave digger. The first digit in the code is the most general in meaning, referring to one of the seven major occupational groups. The subsequent digits refer, in turn, to finer and finer classifications. In Table 12 a general outline is given of the system of classification of occupations. It will be noted that for jobs with code numbers beginning with 4 through 9, the classification is twofold; in one grouping, the jobs are classified according to skill, and in the other, according to industry or type of activity. There is no hierarchical order of jobs from "good" to "poor," or "desirable" to "undesirable." The classification is based solely on the similarity and interchangeability of the jobs.

It seems likely that the technique utilized by the U.S. Employment Service is more practical when one is primarily interested in the extent to which jobs can be interchanged. In making decisions relative to persons applying for unemployment insurance, for example, such a classification will be particularly useful. If no other jobs are available in the occupation to which the job applicant belongs, he truly could be classified as unemployed, even if jobs in other occupations were available. On the other hand, if other jobs in that occupation are open to the applicant, he could not be classified as unemployed since, presumably, he could satisfactorily perform the work of these jobs.

Such a classification of jobs also should prove useful in the development of occupational tests. Tests to measure occupational aptitude rather than aptitude for specific jobs could be constructed. Such tests would be especially valuable in vocational guidance and also in the selection of employees by organizations that are too small, or are not adequately equipped, to develop specific aptitude tests.

TABLE 12.—GENERAL OUTLINE OF CLASSIFICATION OF JOBS IN THE U.S. EMPLOYMENT SERVICE DICTIONARY OF OCCUPATIONAL TITLES

- 0– Professional and managerial occupations
  - 0–0 through 0–3 Professional occupations
  - 0–4 through 0–6 Semiprofessional occupations
  - 0–7 through 0–9 Managerial and official occupations
- 1– Clerical and sales occupations
  - 1–0 through 1–4 Clerical and kindred occupations
  - 1–5 through 1–9 Sales and kindred occupations
- 2– Service occupations
  - 2–0 Domestic-service occupations
  - 2–2 through 2–5 Personal-service occupations
  - 2–6 Protective-service occupations
  - 2–8 through 2–9 Building-service workers and porters
- 3– Agriculture, fishery, forestry, and kindred occupations
  - 3–0 through 3–4 Agricultural, horticultural, and kindred occupations
  - 3–8 Fishery
  - 3–9 Forestry, hunting, and trapping
- (4– and 5– Skilled; 6– & 7– Semiskilled; 8– & 9– Unskilled)
  - 4–, 6–, 8–00 through 5–, 7–,- 9–19 Occupations in manufacturing and related activities
  - 4–, 6–, 9–01 through –10 Production of food products
  - 4–, 6–, 8–12 Manufacture of tobacco
  - 4–, 6–, 8–14 through –10 Manufacture of textiles
  - 4–, 6–, 8–21 through –27 Production of fabricated textile products
  - 4–, 6–, 8–29 through –39 Production of lumber and lumber products
  - 4–, 6–, 8–41 through –42 Production of paper and paper goods
  - 4–, 6–, 8–44 through –49 Printing
  - 4–, 6–, 8–50 through –53 Production of chemicals and chemical products
  - 4–, 6–, 8–55 through –56 Production of petroleum and coal products
  - 4–, 6–, 8–57 Production of rubber goods
  - 4–, 6–, 8–59 through –62 Manufacture of leather and leather products
  - 4–, 6–, 8–65 through –70 Production of stone, clay, and glass products
  - 4–, 6–, 8–71 through –95 Metalworking occupations
  - 4–, 6–, 8–97 through –99 and 5–, 7–, 9–00 Manufacture of electrical equipment
  - 5–, 7–, 9–02 through –05 Manufacture of transportation equipment
  - 5–, 7–, 9–08 through –13 Manufacture of miscellaneous products
  - 5–, 7–, 9–16 through –18 Miscellaneous manufacturing occupations
  - 5–, 7–, 9–20 through 5–, 7–, 9–61 Occupations in nonmanufacturing occupations
  - 5–, 7–, 9–20 through –22 Extraction of minerals
  - 5–, 7–, 9–33 Construction occupations
  - 5–, 7–, 9–35 through –49 Transportation occupations
  - 5–, 7–, 9–51 through –54 Communication and utility occupations
  - 5–, 7–, 9–55 through –60 Trade and service occupations
  - 5–, 7–, 9–61 Public-service occupations
  - 5–, 7–, 9–63 through 5–, 7–, 9–89 Miscellaneous occupations
  - 5–91 through 5–99 Foremen
  - 7–93 through 7–99 Apprentices

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CHAPTER III

CRITERIA OF PROFICIENCY ON THE JOB

In this chapter problems connected with the worker's effectiveness on the job will be discussed. As we have a description of the job in terms of the job specifications, and a description of the abilities and traits required of the worker as given in the worker specifications, the next problem is to devise and put into operation valid measuring instruments for determining the degree to which workers are successful in executing the duties of the job. The job and worker specifications are qualitative descriptions of the job. The description of the worker's proficiency on the job should be quantitative. Although the degree to which an individual will be able to perform successfully on a job will vary with the degree to which his abilities correspond with the worker specifications for that job, there is no better way of determining his actual accomplishment than by measuring his proficiency while performing on the job.

PURPOSES SERVED BY PROFICIENCY MEASUREMENTS

By *criterion* is meant any attribute or accomplishment of the worker that can be used as an index of his serviceability or usefulness to the organization that employs him. Proficiency measurements, then, are criteria. Valid criteria are found to serve many useful purposes. Probably that aspect of business and industry in which they are most frequently encountered is in the promotion, separation, or transfer of workers. It is obvious that the employer needs some measure of the workers' proficiency as a basis for determining which one of several workers deserves to be promoted. Jobs at the top levels of responsibility are fewer in number than those at lower levels. There are always several candidates for a job, and selection of the most deserving is a necessary procedure.

The task is a difficult one because of the many psychological factors involved. Usefulness to the organization is not a simple variable that can be reduced to seniority, as so frequently is done. It cannot always be restricted to a measure of productivity such as the number of finished articles produced, as again so frequently is done in industry today. Neither should the promotion be based solely on the personal judgment of a supervisor, which is another widely accepted method. To be sure these are standard procedures that deserve to be considered, but only together with many other criteria, all of which should be evaluated in terms of their validity. The point to remember is that, although it is obvious that the employer needs some criterion on which to base promotions, the selection of the most suitable measure for a given job, at a given time, with a given number of qualified candidates, is not at all a simple task.

Promotions, however, are only one phase in which criteria are essential. Criteria of proficiency on the job serve equally important functions in separations, transfers, establishment of wages, bonuses, and many other phases. Following is a list of purposes for which valid quantitative criteria are used:

1. As a basis for the promotion, separation, or transfer of workers.
2. As a means for evaluating the effectiveness of the work of an organization, or of its separate departments.
3. As a basis for the payment of piecework wages, bonuses, etc.
4. As a means for evaluating the effectiveness of different methods of work, tools and equipment, and conditions of work.
5. As a means for evaluating the effectiveness of devices used for the selection and classification of workers.

In studying the foregoing list the reader should be struck with the fact that criteria are needed throughout most of the phases of business and industry, and that no worker, no department, no process of production, no method of work, and no policy is exempt from being examined in terms of measurement, evaluation, and justification. These functions are best served by quantitative criteria. This is not being stated as a new problem. It is an old problem in business and industry, and many procedures have been devised for its solution. It is a problem, however, that, for the most part, has not been given systematic and scientific scrutiny. Few criteria are available today which have known dependability and for which there is some quantitative statement of their efficacy. Sound methodological techniques are now available by which the dependability of any measure of proficiency can be determined, and an understanding of these techniques should go far toward effecting an improvement in present-day methods of measuring worker proficiency. It is to a consideration of these methods that the present chapter is devoted.

KINDS OF PROFICIENCY MEASURES

A little reflection on worker performance will reveal that the kinds of proficiency measures are as varied as the ways in which the worker successfully contributes to the organization. Some criteria have a limited application because they involve factors that characterize only a few jobs, whereas other criteria have very wide usefulness because they involve factors characteristic of a large number of jobs. It follows that in selecting a measure for a specific job there will be certain conditioning factors that must be given consideration. One such factor is the purpose for which the measure is to be used. A criterion useful for one purpose will not necessarily prove useful for a different purpose. The nature of the job, likewise, in part, will determine which of several criteria can profitably be utilized. There are other factors of this nature that will be discussed in the descriptions of the individual measures used in estimating job proficiency.

The following measures are in current use in business and industry:

Amount and quality of output
Work-sample tests
Length of service
Amount of training necessary
Ratings by superiors

PRODUCTION AS A MEASURE OF PROFICIENCY

Amount and Quality of Output.—Output is probably the most commonly used measure of job proficiency and often is considered the best. Typical criteria based on output are the number of units produced in a given interval of time, the time required to produce a given item, amount of sales per given time period, etc.

The amount of output, *i.e.*, the number of units of work the employee turns out in a given unit of time, should, when used as a criterion of proficiency, be considered in relation to the quality or accuracy of the work. For example, an employee who turns out 100 units of work, all of which are perfect, must be considered better than one who in the same time turns out twice as many units, most of which are defective. Similarly a department-store salesperson who has a high sales record, but a large number of whose customers return purchased articles, cannot be considered as effective an employee as another whose sales are somewhat lower but whose returns are negligible. In all cases then the amount of output must be adjusted in terms of the quality of the work.

One method of making the adjustment involves an evaluation of the time, material, or cost involved in the imperfect or spoiled production. If an imperfect article must be sold at a reduction of 25 per cent from the market price of a perfect article, this reduction forms a quantitative basis for adjusting the output of workers turning out the imperfect articles. For each imperfect unit the worker would be credited with having completed three-quarters of a unit of work rather than a whole unit. If the work is of such a nature that any error committed must be corrected, *i.e.*, if the spoiled article must be discarded and another perfect one substituted in its place, then the time involved in producing the perfect article, or the cost of the materials in the discarded article, or both of these factors can be used in adjusting the output.

Sometimes correcting an error requires more time than is involved in producing several correct articles, and in such a case the penalty of a mistake should be rather severe. The manner in which such corrections can be made may be illustrated by a study of Hollerith card-punch operators made by the U.S. Employment Service.[1] An investigation of errors indicated that on the average 13.75 cards could be punched while one error was being corrected. Consequently in determining the output of a card-punch operator 13.75 cards were subtracted from the total punched for every card on which there was an error. For example, if an operator made two errors in punching 228 cards in 1 hr., 27.50 cards would be subtracted from the total, and the operator's output for 1 hr. would be taken as 200.50.

The Problem of Comparable Units.—The basic prerequisite in the use of output as a measure of job success is that the units of work for all employees must be comparable.[2] By comparable is meant that the work units should be approximately equivalent in terms of the workers' time, accuracy, and energy. That is, if on job A each product that can be turned out with normal expenditure of worker energy requires 2 hr., and the possibility of error is small, then in an 8-hr. day the average worker should turn out four articles. Now if on job B with normal expenditure of worker energy the construction of an article requires 30 min., if the possibility of error is present and is equivalent on the average for a day's work to one-fifth article per error, and if the average number of errors per day is 10, then the number of completed articles per day is 14. On the average, then, 4 articles on job A are equivalent to 14 articles on job B. To give a concrete example, the output of an individual in a bottling plant who is inspecting quart containers is not directly comparable with that of one who is inspecting pint containers, since the tasks may be of unequal difficulty in spite of the fact that they both involve the inspection of glass containers. It is to be remembered that even if the employees are working in the same department or handling similar items, using just the simple criterion of number of items is not an adequate basis for comparing their output.

A number of different methods have been developed for transmuting into comparable scales the output records of workers doing somewhat different tasks or working under different conditions. We shall here discuss several methods that involve either a comparison of each individual's output with that of the subgroup of workers to which he belongs, or a comparison of each individual's output with a standard output estimated to be that of a "normal" or "average" worker.

Achieving Comparable Measures by Comparison with the Average. This method is employed when the tasks performed by all workers are the same, or approximately the same, but where the units of measurement differ for different subgroups of workers, or where certain factors operate to influence differentially the output of different groups of workers. In a department store, for example, in one department devoted to articles selling for very small amounts, such as 25 cents or less, the productivity of the salespersons might be measured in terms of the number of items sold per day. In another department where expensive articles are sold, productivity might be measured in terms of the dollar value of goods sold per day. Obviously the two different units by means of which productivity is measured are not directly comparable. It would be incorrect to say, therefore, that a salesperson in the first department who sold 700 items per day was either a better or poorer salesperson than one who sold $85 worth of goods in the second department. Without some reference point to which each worker's productivity can be referred, such as the average sales of the worker's department, comparisons would be impossible.

Similarly, in a factory where some workers operate older and slower machines and others newer and faster machines, direct comparisons in output between workers in the two groups would be fallacious even though the finished articles would be the same. It would be expected that the output of the first group would be less than that of the second group simply because their machines are slower. Again some procedure is needed for adjusting the output of the workers in order to eliminate the error introduced by the differential effect on performance of the speed of the machines.

One way in which adjustments in output are made for situations such as those described is to express each individual's output as a ratio of the average output of all the workers in his subgroup.[3] In order to avoid the use of fractional numbers the ratio usually is multiplied by 100. This final number is termed the *index of output.* Each worker's output, then, is expressed as a percentage of the mean for his department or subgroup, and variations between workers are measured in units of percentage. If it may be assumed that units of percentage based on average performance within a group are comparable for different groups, then worker productivity can be compared for workers in different groups.

The manner in which these indices are computed may be illustrated by the following hypothetical example. Suppose that employees in a plant, all of whom are doing the same machine task, are assigned to one or another of three models of the machine. These models—A, B, and C—perform essentially the same operations but vary somewhat in nature of controls and speed of operation. Differences in amount of production may be expected from the workers in accordance with the characteristics of the machines assigned to them. In the left half of Fig. 3 are given the distributions of the production rates of workers assigned to each model of the machine. In general the production rate of workers assigned to machine A is lowest, and that of workers assigned to machine B is highest, the average rate of production being 220 for machine A, 300 for machine B, and 280 for machine C. The index of output for a person on machine A whose output is 242 would be $^{242}/_{220}$ or 110. This would mean that this worker was better than average, since an average index would be 100. However, a person whose rate of production on machine B was 242 would have an index

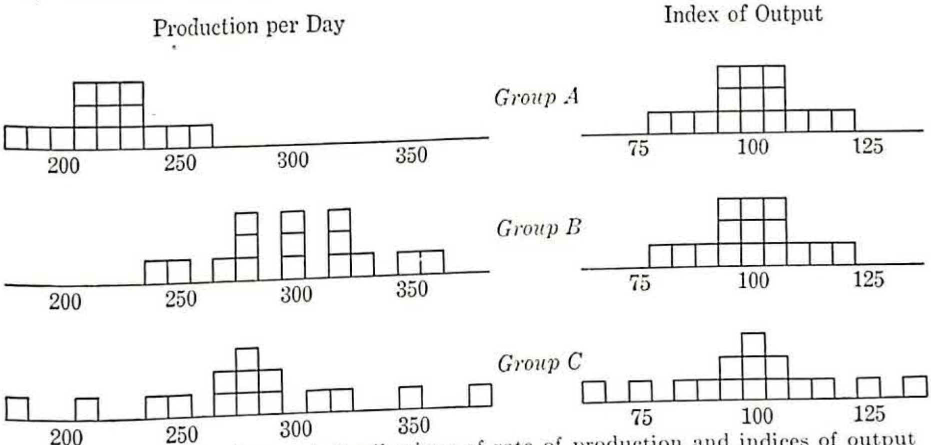

Fig. 3.—Comparisons of distributions of rate of production and indices of output for three hypothetical groups of workers, A, B, and C, each group being assigned to a different model of the same machine.

of output of $^{242}/_{300}$ or 81, and clearly would be performing below the average.

If each worker's production is divided by the average production of all individuals working on the same type of machine, then a basis is obtained for learning about the relative productivity of workers using different models of machines. These computations have been performed for the three groups of workers, and the distributions of their indices of output are given in the right half of Fig. 3. It will be observed that this transformation renders the productivity of the three groups far more comparable than if it had been based solely on the actual production records of the workers.

There are certain difficulties with indices of output computed on this basis, which should be given consideration before they are employed.

1. The average production of each of the subgroups of workers must be based on a number of cases sufficiently large that it will be stable and reliable. With small groups of workers, as in the hypothetical case given above, the averages would be too unreliable to be used as bases for evaluating individual workers. Unfortunately, however, this is just the sort of situation where this type of index is most needed. In a department store, for example, sales vary from department to department due to variations in the selling situation and the nature of the goods offered for sale. For this reason some procedure is needed to render their gross sales comparable. Since at most there will be only 15 or 20 persons in any one department, no great confidence can be put in the stability of the average of the sales in the different departments.

2. The variability in the indices of output for the various groups must be the same. If the indices for one group of workers cluster closely around the average of 100, while in another group the indices deviate far below and above 100, then the output indices of these two groups cannot be considered comparable. In Fig. 3 the distributions of the indices of output of workers assigned to machines A and B have the same variability, while the distribution of indices of workers assigned to machine C is much more variable, containing more very high and very low indices. It might well be that the characteristics of machine C are of such a nature that inferior workers are unduly penalized, and superior workers are correspondingly given an undue advantage. The best worker on either machine A or B can achieve an index of only 120, whereas one on machine C can achieve an index as high as 135.

3. The workers in the various subgroups must be comparable in

ability. If over a period of time the better workers were assigned to one group and the poorer workers to another group, then reducing their production rates to a comparable basis would penalize the superior workers and give an undue advantage to the inferior workers. The selective placement of workers in different groups on the basis of differences in their ability is common practice. In a factory the more able workers are assigned to the faster machines, and in a department store the better salespersons are assigned to departments where the goods are more valuable and the sales are likely to be higher. If any wide differences of this nature exist between two groups, the method of achieving comparable indices of output as described above should not be used.

Achieving Comparable Measures through Standard Scores.—A more statistically refined technique for rendering the production of different groups comparable, but one basically similar to the ratio method just described, is the standard-score method. In the ratio method the reference point used as a basis for establishing the comparability of different individuals' performance was the average. In the standard-score method two reference points are used, viz., the average and the variability.

In Fig. 4 are given the frequency distribution curves of production of three hypothetical groups of workers, A, B, and C. Again it is supposed that the differences in the productivity between the three groups are due to factors beyond the workers' control, such as variations in the machines to which they are assigned, or similar factors that differentially influence production. It will be observed that the average output of group C is the highest and that of group B the lowest. In addition, the production figures of group A cover a wider range than those of group B or group C, *i.e.*, the performance scores vary more in group A than in either group B or C.

It is obvious that members of the three groups cannot be directly compared on the basis of uncorrected production figures. In effecting the correction based on standard scores, the average (mean) and the standard deviation must be computed separately for each group. Then each individual's production is expressed in terms of its distance from the mean of his group when measured in terms of the standard deviation of the group. The standard deviation serves as a unit of measurement by which the distance of the individual's performance from the mean of his group can be expressed quantitatively.

For example, the mean and standard deviation of group A are 74 and 8, respectively (Fig. 4). Thus an individual in group A whose production was 70 would have a standard score of (70 − 74)/8, or −0.5, and therefore would be considered slightly below the average. A worker in group B whose production was 70, where the mean of the group is 66 and the standard deviation is 4, would have a standard score of (70 − 66)/4, or +1.0. This worker would be considered to be somewhat above the average. It should be apparent that the mean of a group does not vary from itself, and therefore when a performance falls exactly at the mean its value in terms of the standard deviation unit is zero.

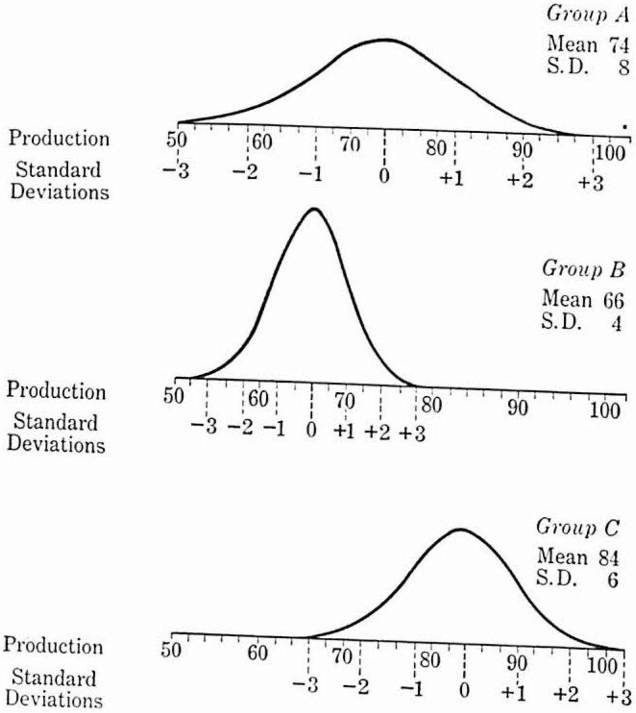

FIG. 4.—Distributions of production records of three hypothetical groups of workers whose output varies between groups due to variations in working conditions.

The value of the standard-score correction is that it equates the groups not only in terms of mean performance but also in terms of variability. However, although it overcomes the difficulty of the ratio method in regard to variability, it shares other difficulties with it. One difficulty that may arise is attributable to differences in the shapes of the distributions of scores of the different groups; this also is a difficulty with the ratio method that was not discussed under that topic. If the shapes of the distributions of production of the various groups are not the same, then the standard scores will not have the same meaning for all groups. Curves A and B in Fig. 5 are the frequency distribution curves of standard scores of two groups. It will be noted that the curves differ in shape, although the means and standard deviations are the same for the two groups. It will be observed that a much smaller proportion of group A than of group B earn scores greater than +1. A score of +1 in group A is one that is surpassed by only 8 per cent of the group, whereas the same score in group B is surpassed by 17 per cent. Thus, when the shapes of the distributions of scores of the various groups are not the same, equal standard scores in these groups cannot be interpreted as indicating the same relative position in the groups.

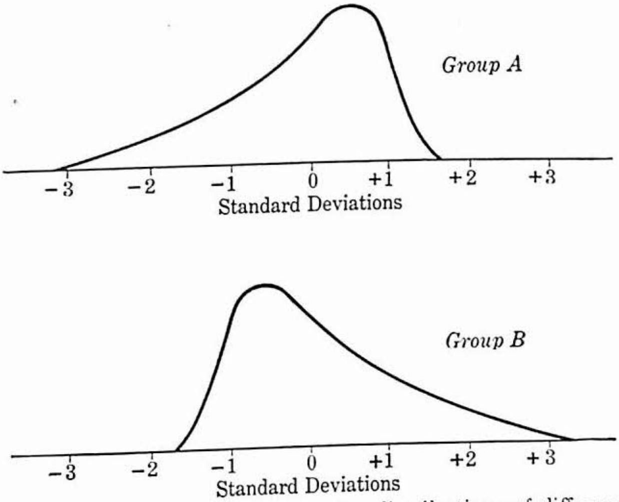

FIG. 5.—Comparisons of standard scores for distributions of different shapes.

Achieving Comparable Measures through the Percentage Efficiency Index Based on Time-study Standards.—In certain cases it is impossible, or contrary to policy, to use the average production of a group of workers as a standard for the computation of a production index. The solution in such instances is by means of time study to set the standard on the basis of the time it is estimated that the average worker would take, or the time it should take for a "reasonably proficient" worker to complete the task. In computing a production index for a given worker, the actual time taken by him to complete a task—his "clock hours"—is compared with the standard time, or "earned hours," set by the management for completion of the task. Suppose, for example, that the earned-hour standard for task M was

45 min., and that for task N was 60 min. A worker who took 30 min. to complete task M and 50 min. for task N would have a production index of $^{45}/_{30}$, or 150, for task M and $^{60}/_{50}$, or 120, for task N. For the total time worked, his production index would be $45 + 60 \div 30 + 50$, or 131. Production indices of this sort are usually called "percentage efficiency" indices.

The adequacy of this method obviously rests upon the adequacy of the standard established through time study for the earned hours. If the standards are inaccurate, then the production indices for different pieces of work will not be equivalent. To illustrate the effects of inaccurate time standards, a hypothetical case is given in Table 13.

TABLE 13.—AN EXAMPLE OF THE EFFECTS OF INACCURATE "EARNED-HOURS" STANDARDS UPON THE PERCENTAGE EFFICIENCY RATINGS

Standard	Item of work M performed by worker X	Item of work N performed by worker Y
Inaccurate earned-hours standard	20	16
Accurate earned-hours standard	15	18
Clock hours	19	17
Per cent efficiency based on inaccurate hours standard	105	94
Per cent efficiency based on accurate hours standard	79	106

If the standard set by time study or other means for an item of work M, which is done by worker X, is too liberal, and that for an item of work N, which is done by worker Y, is too severe, then worker X's production index will be too high, while that for Y will be too low. Only when workers are doing the same tasks will their indices be comparable, since, even though the standard time is too high or too low, the error is constant for all individuals.

However, the production index, in and of itself, cannot be interpreted in the sense of being either too high or too low, since the base on which it is computed is inaccurate. All that can be said is that one worker is better or poorer than another, but not that either is good or poor. This problem becomes particularly important when the production index is utilized for the purpose of establishing wages, or is used for the classification of workers as either good or poor.

In setting time standards two factors are involved, viz., operation time and extra time allowances. Operation time consists of the time required for the actual movements involved in completing the task, the speed of operation of machines, etc. Extra time is added to operation time in order to allow for differences in skill and effort between the worker or workers used in setting the operation time and the general run of workers, unavoidable delays and work stoppages beyond the control of the worker, personal needs of the worker, and reduction in the individual's rate of work due to prolonged effort. It is to be noted that allowances made for these four factors generally will be arbitrary. For example, in many cases there is no way of knowing the cause of a delay, and hence it is difficult to classify it as avoidable or unavoidable. The fact that the amount of such time allowances is arbitrary is indicated by the variation found in these allowances from one plant to another. It is reported that the allowance for personal needs ranges from 2 per cent to 5 per cent of operation time, and the allowance to be made for reduction from prolonged work varies from 10 per cent to 15 per cent.[4]

Attempts to equate for differences in skill and effort between the worker or workers used in setting operation time and the general run of workers have been found to be inadequate when subjected to systematic examination. In one investigation of a factory operation, for example, it was found that the speed of operation of the most rapid worker was 67 per cent greater than that of the slowest.[5] When "leveling" factors were applied to compensate for estimated differences in skill and effort, the superiority of the best worker was still very large, being as much as 53 per cent. If the correction factors had been adequate, the differences between workers should have disappeared.

Production standards may be established through the use of several different methods. Essentially these can be reduced to the following: estimates based upon purely rational analyses, estimates based upon experience gained from speed of work on similar tasks, the time required by pace setters or other specially selected workers, and time-and-motion analyses. Clearly the first two methods will yield arbitrary estimates, and the third is very likely to be in error due to the fact that the standard time will be based upon the performance of a very few workers who very likely will not be representative of the general group upon which the standard is to be used. This last limiting factor also may render uncertain the estimates based on time-and-motion studies. A further limitation of time-and-motion analysis is that it is based on the untenable conception that the times required to do parts of a task are combinable into a total time for the whole task. This notion will be examined in more detail in a later chapter.

In summary it may be said that the use of the ratio of standard time set for completing a task to actual time taken by the worker as an index of proficiency is likely to give an inaccurate measure of success. Owing to the nature of the situation and the number of factors involved, the extent of error will necessarily and unfortunately be unknown.

OTHER MEASURES OF PROFICIENCY

Work-sample Tests.—If it is desirable to use productivity as a measure of job success, but the working conditions are such that measures of output are difficult or impossible to obtain in the plant or office, work-sample tests may be used. In a work-sample test the employee performs exactly the same work as that involved on the job, either for a fixed and limited time, or until a given number of items of work are completed. For example, with filing clerks it is difficult in the actual office situation to count the number of letters correctly filed. Similarly with a machine operator an observer counting the number of items of work completed might well interfere with the general flow of the work. Consequently such tests are usually conducted in a separate room, in some segregated part of the plant, or at a machine or workplace especially arranged, so that output can be measured without interfering with the testing procedure or with the normal work output.

The obvious advantages of using work-sample tests are that extraneous and unimportant factors are eliminated, and that accurate records can be obtained. One difficulty with the use of output records of employees routinely obtained in the actual working situation is that very often they are not accurately kept. However, as Bingham and Freyd have pointed out, the usefulness of work-sample tests will be in direct proportion to how well they represent the actual work on the job.[6] It will be a temptation to simplify the situation in such tests until they no longer reflect all the important aspects of the job.

Length of Service.—If a job is such that the organization must spend considerable time and money in training employees, an individual who completes the training and shortly thereafter leaves the job must be considered an unsuccessful employee. Consequently in many situations the ability of the individual to continue on the job is an important measure of his success. This criterion also probably measures the individual's ability to adjust himself to the working conditions, his ability to get along with his fellow workers, his satisfaction with the job, and similar factors. In addition it may measure to some degree his ability to perform the work involved in the job, since inferior workers will be detected and released or transferred to other jobs. However, the relative importance of each of these factors in the determination of the length of time the employee stays on the job certainly will vary markedly from job to job, so that for a given job the meaning of this measure will not be clear, unless some system of exit interviewing is established in order to discover the causes of separation.

Amount of Training Necessary.—On jobs that require that the organization train the worker for the job, the individual who takes a long time to finish such training, by and large, cannot be considered as good as one who learns in a relatively short time. Consequently this criterion is commonly used where the training period is expensive to the organization, where the trained employees are relatively homogeneous as to job proficiency, or where training time is related to later success.

If training time is used as an index of the worker's potentiality for later success on the job, it is important that the relation between these two factors be carefully determined. Since the employees being trained usually do not come to the organization with the same amount of past experience related to the job for which they are in training, any such related past experience will tend to produce individual differences in the required training time. If this related experience can be measured and taken into account in evaluating the length of time taken to complete training, a more accurate appraisal of training time as a measure of subsequent success on the job will be attained.

Ratings by Supervisors.—The opinions of foremen, managers, and others in authority are used as measures of job success, such opinions being recorded on some kind of rating form. This criterion has enjoyed rather wide use and frequently has been abused. The various types of rating techniques and the problems involved in ratings will be discussed in the next chapter.

STANDARDS FOR EVALUATING A MEASURE OF PROFICIENCY

A criterion of proficiency may be readily obtainable in the sense that quantitative records of one sort or another relative to workers' success may be available for all or most individuals on the job, but mere number of quantitative records should not be taken as solving the problem of criterion measurement. The criterion should meet certain standards before it is considered adequate.[7] The two most important standards are representativeness, frequently known as validity, and consistency or reliability.

Representativeness.—The adequacy of a measure of proficiency will be a function of how representative the criterion is of the job it purports to measure. If the measurement involves items not contained in the actual work situation or items concerned with minor aspects of the job, the order of individual differences among the workers in *measured* job proficiency will bear little similarity to the order of individual differences of these workers in *actual* job proficiency. For example, a work-sample test would not yield a valid index of job performance if it were conducted under highly artificial conditions. In such a case distracting influences, which operate to reduce the output of some but not other workers on the job, would not be present in the test and hence would not be measured.

Measures of output obtained in the actual working situation would be a deficient criterion if success on the job were mainly dependent upon the workers' ability to get along with their fellows. Before output could be considered an adequate and representative criterion, it first would have to be demonstrated that any differences in success on the job attributable to ability to get along with other workers were adequately reflected in the differences obtained in the output criterion. This factor of getting along with others is of considerable importance in job success, if causes of separation are to be credited with reflecting success, since in a large proportion of the cases the reason given for the separation of employees is not lack of ability to do the work but rather some defect or limitation of personality. Seldom, however, are attempts made to include this factor in measures of success on the job. That the measure of proficiency must represent the job, then, is of prime importance.

The only practical way of judging representativeness is to check thoroughly the measured characteristics against the important aspects of the job as revealed by the job specifications. Since some aspects of the job will be easier to measure than others, there will be a tendency to overlook certain less measurable but possibly equally important parts. In this connection it should be pointed out that some qualitative estimate of an important but difficult-to-measure aspect of a job may prove a better criterion than an accurate quantitative measure of a minor aspect of the job. A careful study of the job of department-store salespersons probably would reveal that the successful salesperson is not always one who makes the greatest number or amount of sales but may be one who makes a favorable impression on the customer so that, even though she does not purchase from that salesperson, she purchases from another in some other department of that store rather than go to another store.

More representative measures of such intangible factors as those mentioned above sometimes can be obtained by using customer reactions.[8] Ratings or some other form of evaluation of a salesperson are obtained from established customers who have been served by that salesperson on several occasions. Such a method is applicable to most retail merchandizing situations. Again, instead of estimating the success of a foreman or of a supervisor by obtaining a rating from his superior, a more representative measure sometimes can be obtained from the reactions of the foreman or supervisor's staff members or others working under him. Burtt suggests the use of another measure for a supervisor or foreman, viz., the total output of the workers in his department.[9]

To achieve representativeness may require that different workers in the same department be evaluated by means of entirely different performance measures. Stead and Shartle have pointed out that successful measurement of proficiency sometimes requires more than one type of criterion within a department.[10] These authors have argued that success has many connotations. One worker may be considered successful because he raises the morale of the entire group, another because of his ability to do odd jobs in addition to his regular job, and a third because his production figures are always high. By and large, this matter has not been given systematic study. Such a situation is very likely to arise in a job that is not rigidly defined, or in one where the employees have interchanged duties or do not work according to the specified duties of the job. The example of retail salespersons discussed in a previous paragraph serves as a case in point. One salesperson might be considered successful even if his sales are low, if he successfully builds up such good will in the customers that they buy most of their goods in that particular store, and of course they would be buying in departments other than his.

Reliability.—The reliability of a measure of proficiency is another important factor in determining its adequacy. By reliability is meant consistency or reproducibility. A criterion is reliable if it gives the same results on two or more occasions. The reliability of a measure should be tested for and determined by statistical analyses and not merely be assumed or, even worse, totally ignored. It is often believed that a measure of proficiency will necessarily have high reliability because it is based on the workers' actual performance on the job.

That this is not the case may be seen from the figures presented in Table 14, which are typical reliability coefficients of measures of job success.[11] It will be noted that only two of the coefficients are 0.90 or above. For accurate measurements of individuals these are satisfactory. Coefficients in the 0.80's are borderline and should be improved. Coefficients in the 0.70's are definitely too low, and improvements in the criteria should be effected before they are put to practical use.

TABLE 14.—EXAMPLES OF THE RELIABILITY OF CRITERION MEASURES OF JOB SUCCESS

Reliability coefficient	Job	Criterion	Time
0.78	Insurance salesmen	Sales	Two 1-year periods
0.78	Shopworkers	Output	Two 3-month periods
0.87	Coil winders	Output	Two 4-month periods
0.81	Benchworkers	Output	Two 2-week periods
0.88	Department-store salespersons	Sales	Two 6-month periods
0.90	Card-punch operators	Errorless production	160 hr., odd-even periods
0.96	Typists	Speed	Work-sample test

The reliability of measures of proficiency may be estimated either by repeating the measurements twice on the same group of employees and obtaining the coefficient of correlation between the two repetitions, or by estimating the reliability of the total measure from correlating the scores obtained by splitting the results into comparable halves.[12] An example of the former method would be the correlation between the scores of a group of employees on two repetitions of the same work-sample test, or the correlation of amounts of sales for two periods of time (see Table 14). An example of the second method would be the corrected correlation between the output records of a group of employees on the odd and even months of a year, or the number of accidents of workers on the odd and even days of a month.

Reliability and the Number of Measurements.—Two important factors influence the size of the reliability coefficient, viz., the number of measurements obtained and the range of ability or proficiency in the group being measured. In Table 15 may be seen an evaluation of the effects upon the reliability coefficient of increasing the number of independent measurements made on each worker being evaluated.

TABLE 15.—THE EFFECT OF INCREASING THE NUMBER OF MEASUREMENTS UPON THE RELIABILITY COEFFICIENT

Original reliability coefficient	Number of times measure increased								
	2	3	4	5	6	7	8	9	10
0.10	0.18	0.25	0.31	0.36	0.40	0.44	0.47	0.50	0.53
0.30	0.46	0.56	0.63	0.68	0.72	0.75	0.77	0.79	0.81
0.50	0.67	0.75	0.80	0.83	0.86	0.88	0.89	0.90	0.91
0.70	0.82	0.88	0.90	0.92	0.93	0.94	0.95	0.95	0.96
0.90	0.95	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99

It will be observed that, as the number of measurements increases, the reliability of the measuring device increases, but with diminishing returns. If, for example, the reliability coefficient of a 10 min. work-sample test were 0.50, increasing the length of the test to 1 hr. should increase the reliability to approximately 0.86. If the reliability of ratings by a single foreman were 0.70, the pooled ratings of four such foremen would probably be around 0.90.

It also will be noted from Table 15 that if a measure of proficiency has a low initial reliability, the number of additional measurements necessary to increase reliability to an adequate level will be too large to be practical. This is of particular importance with measurements requiring considerable time or a large number of raters. Thus, if production records for a 6-month period had only a reliability of 0.30, it would mean that records would have to be taken on each worker for nearly 5 years in order to raise the reliability to 0.80. Similarly, if the reliability of the pooled ratings of three foremen were 0.30 (a situation not infrequent), 30 such foremen would have to be used to raise the reliability of the pooled ratings to as much as 0.80. Measures found to have a reliability so low as to preclude further increases in length should be analyzed for correctable defects that might attenuate or lower the reliability coefficient. Sometimes merely an improvement in the accuracy of record keeping or a more precise description of the output will be sufficient to increase the initial reliability to a workable level.

Reliability and the Range of Ability.—As the range of individual differences in ability or performance becomes smaller and smaller, the reliability coefficient decreases. Therefore, if a reliability coefficient of a measure of proficiency is determined from the performance of a group whose range of ability is less than that of the total group on which the measure is to be used, the reliability coefficient will be too low. In order to obtain an adequate measure of reliability when all employees cannot be tested or records obtained from them, a sample of workers truly representing the range of ability of the total group should be used, and not a group restricted to any particular range of ability such as the superior, the average, or the inferior.

The specific effects of reduction in range of individual differences upon the reliability coefficient may be seen in Table 16. Suppose that the production records of the upper 10 per cent and lower 10 per cent of the employees were not included in the determination of the reliability of output, then the range of individual differences would be 20 per cent less than that of the complete range. If the reliability coefficient of output, computed from this group with reduced range, were found to be 0.53, reference to Table 16 will show that the reliability coefficient for the total group would probably be 0.70. Table 16 also shows that the lower the reliability coefficient, the more it is decreased from a reduction in range.

TABLE 16.—THE EFFECTS OF REDUCTION IN THE RANGE OF TALENT OR INDIVIDUAL DIFFERENCES UPON THE RELIABILITY COEFFICIENT

Reliability coefficient of the total range	Reduced range expressed as a percentage of the original range				
	90 %	80 %	70 %	60 %	50 %
	Reliability coefficient				
0.90	0.88	0.84	0.80	0.72	0.60
0.70	0.63	0.53	0.39	0.17	0.00
0.50	0.38	0.22	0.00	0.00	0.00
0.30	0.14	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00

The range of ability will be an important factor in cases such as those where output records are taken over a long period of time. The reliability of the criterion must be determined by using only those employees who remain on the job for the period under consideration. If there is any labor turnover, it probably will not be equal at all levels of job proficiency. It seems quite likely that those workers who leave the job will be either inferior workers who become discouraged and quit or who are released because of low productivity, or superior workers who are promoted and given other jobs or leave the organization for better jobs. The range of ability of those workers who remain during the total time period, then, will be much smaller than the range of the whole department or plant personnel at any given time during that period.

An Interpretation of Reliability.—If the importance of using proficiency measures of high reliability is to be fully recognized, it is necessary that the reader have a clear conception of what actually occurs when a criterion of low reliability is utilized. This can be gained, in part, by considering the following example. Suppose a bonus is to be given to the better workers, and it is decided that only the upper 50 per cent in proficiency will be made recipients. The problem is to obtain a criterion that will reliably select this upper 50 per cent. In this case it has been decided that the foreman's ratings will be used. Foremen's ratings in the past have been found to have rather low reliability. This means that if a foreman rates each of his men on two separate occasions, all those who obtain a high rating on one occasion will not be given a corresponding high rating on the other occasion. The influence of unreliability of measurement, then, may be considered in terms of the individual's chances of falling above the average on two separate measurements in which the same criterion is used.

Taylor and Russell have developed tables that are useful in connection with this problem.[13] An adaptation of their material is given in Table 17, which can be used for the case under consideration in which the upper 50 per cent of the workers are to be given bonuses. If the reliability of the ratings is 0.50, then only 67 per cent of the

TABLE 17.—THE PERCENTAGE OF CASES FALLING IN THE UPPER HALF ON ONE SET OF MEASUREMENTS WHO ALSO FALL IN THE UPPER HALF ON A SECOND SET OF MEASUREMENTS IN RELATION TO THE COEFFICIENT OF CORRELATION BETWEEN THE TWO SETS OF MEASUREMENTS

Coefficient of correlation	Per cent	Coefficient of correlation	Per cent
0.00	50	0.55	69
0.05	52	0.60	71
0.10	53	0.65	73
0.15	55	0.70	75
0.20	56	0.75	77
0.25	58	0.80	80
0.30	60	0.85	82
0.35	61	0.90	86
0.40	63	0.95	90
0.45	65	1.00	100
0.50	67		

individuals who are given a rating in the upper half of the group on the first set of ratings will also be given a rating in the upper half of the group on the second set of ratings. That is, the chances that a person who is rated in the upper half on one occasion will be rated in the upper half on the second occasion, are 67 in 100. The chances of his not being placed in the upper half on the second set of ratings, then, are 33 in 100. Presumably, the individual has performed at the same level of proficiency during the period of time in which the ratings were made. The unreliability of this criterion reflects the inconsistency of the foreman's ratings and not variation in the worker's proficiency. It therefore must be concluded that in spite of the worker's consistent performance, which would place him in the upper 50 per cent and thus make him the recipient of the bonus, the chances are 33 in 100 that he will be excluded from the upper half because of the inconsistency or unreliability of the foreman's ratings.

This would appear to be too high a price to pay for using a criterion having little to recommend it except convenience, ease of obtaining it, and its widespread traditional use. Especially is it a high price to pay when methods are available for increasing the reliability of the ratings, and when, if satisfactory reliability is not possible, there are other criterion measures whose reliability is acceptable.

FACTORS INFLUENCING MEASURES OF PROFICIENCY

A measure of job success can be representative and reliable and still not be wholly adequate. Extraneous factors influencing the workers' performance but not reflected in representativeness and reliability, may introduce errors. Some of the more important factors of this kind will be considered below.

Experience of the Workers on the Job.—On most jobs there will be a correlation between the length of time on the job and job proficiency, the newer workers being less productive than the older ones. In Fig. 6 is shown the relationship between the monthly production of 31 casualty insurance salesmen and the length of their experience selling for their particular company. There appears to be a rapid increase in productivity up to about 10 months with a very slight increase thereafter. It is clear that the productivity of these salesmen can be compared only when their experience is the same or when it is equalized in some manner.

Since it is often desirable to compare the effectiveness of work of every employee on a job, it is advantageous to correct for the experience variable. One means of reducing the differences in experiences, so that the final criterion measure will be comparable for all workers, is to represent graphically the relationship between amount of experience and the measure of proficiency, determine the trend line best representing the relationship, and then compute each individual's proficiency in reference to this line.[14] In Fig. 6 it will be seen that the average production (as given by the trend line) is $5,500 for salesmen with 3 months' experience, whereas that for salesmen with 20 months' experience is $11,000. A salesman with 3 months' experience whose production is $8,500 is $3,000 above the average for his experience level, while one with 20 months' experience whose production is $8,500 is $2,500 below the average for his experience level. When experience is taken into account, then, the first individual is obviously superior to the second as a salesman.

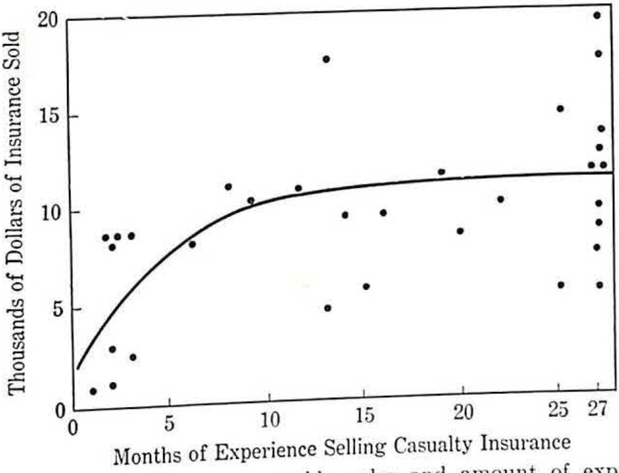

FIG. 6.—The relationship between monthly sales and amount of experience of 31 casualty-insurance salesmen.

Age.—Age is another factor that might distort the measurement of proficiency. In many cases the performance of older workers will differ from that of younger ones. The effect of age may be corrected for in the same manner as was outlined for experience. However, in many cases age and experience will be highly related, so that the correction for the one will automatically correct for some of the effect of the other. If the two are incompletely related, they may be successively corrected for in a manner similar to the method considered above.

Sex.—It is not unusual to find that one sex will be superior to the other on a given job. Under these circumstances some adjustment may be necessary. A very simple solution to the problem is to compare the performance of a given individual with the performance of like-sex individuals by expressing the individual's relative superiority in terms of how far he or she deviates from the average job performance of individuals of the same sex.

The Time Interval during Which the Measurements Are Made.—Job performance has been shown to vary with time of day, day of week, and season of year. Thus the time interval during which the criterion measurements are made will be a further variable that may distort comparisons between workers. Only if it can be shown that each man's relative standing on the job is not affected by the time of day, day of week, and season, should this factor be ignored. It may well be expected, however, that a person's performance will vary systematically from that of another individual with differences in the time variable. For example, in one study it was found that the difference between superior and inferior workers was more marked at the end of the working week than at the beginning.[15] Unless performance on the job can be measured over a long period of time, correction for this time factor will be difficult.

COMBINING SEVERAL MEASURES OF PROFICIENCY INTO A SINGLE COMPOSITE MEASURE

The discussion thus far in this chapter may leave the reader with the erroneous impression that there is always *one* best measure of job success. This is seldom true. For example, determining the relative success or failure of streetcar motormen may require that all the following variables be taken into account:

Number of collisions with vehicles
Number of collisions with pedestrians
Number of traffic violations
Number of commendations received from the public
Number of complaints received from the public
Number of times company rules are broken
Number of sleep-overs (tardiness in reporting)
Number of times schedules are broken
Number of reprimands received from inspectors
Ratings by inspectors
Errors reported by dispatchers

It is apparent from the foregoing list that the success of motormen can be measured in a variety of ways, no single way giving a completely adequate index of success on the job. In order to classify workers on the basis of a single measure of general job success, these separate measures must be combined into a single one. This means that a decision must be made concerning the weight that shall be assigned to each of the component measures of proficiency.

Equal Weighting.—Letting the various component measures carry equal weight in a composite criterion is not a satisfactory procedure, since some components obviously will be more important than others. Arbitrary assignment of equal weight to the various component measures merely ignores the problem rather than solves it. In the following paragraphs consideration will be given to several methods that have been devised for determining weights to apply to different criterion measures in order to combine them into a single composite criterion. In addition a different type of procedure for effecting a combination of several measures of proficiency will be discussed.

Weighting According to Judgments by Experts.—The simplest procedure is to have each of the component criterion measures judged or rated according to its importance by experts, *i.e.*, persons who are very familiar with the job in question. In a discussion group, foremen, supervisors, or other individuals who are acquainted with the job should consider each of the measures, and express opinions concerning the relative importance of each. For practical purposes the judgments by experts would seem to be the best method of arriving at weights for the component measures. Important information, such as the causes of separation of employees, the parts of the work in which employees are particularly effective or deficient, and similar data can be utilized. Thus, the composite criterion would have considerable meaning in terms of the actual job performance.

The primary difficulty with the use of experts' opinions is that satisfactory agreement in their ratings of importance is seldom attainable. To illustrate how such differences among experts lower the dependability of the estimated relative importance of criterion measures, results presented by Stead and Shartle are given in Table 18.[16] Each of six experts rated the importance of a number of proficiency

TABLE 18.—THE CORRELATION OF EACH OF SIX EXPERTS' RATINGS OF THE IMPORTANCE OF A NUMBER OF CRITERION MEASURES WITH THE RATINGS OF THE REMAINING FIVE EXPERTS

Expert	Coefficient of correlation	Expert	Coefficient of correlation
A	0.20	D	0.14
B	0.26	E	0.20
C	0.34	F	0.22

measures on a scale from 0 to 9, and the correlation between the ratings of each expert with the average of the other five was calculated. From the data shown in Table 18 it will be observed that the correspondence between experts' judgments is relatively low. This low degree of agreement is not at all uncommon for such ratings. In another situation, for example, experts rated the importance of ten measures of proficiency for each of three technical jobs. The reliabilities of the ratings of importance for the three jobs were 0.60, 0.41, and 0.34, respectively.

Weighting According to the Reliability of the Criterion Measures.—Another method, which has been used infrequently, is to weight the component measures of proficiency according to their reliability. The argument is that less reliable measures should not be given as much weight as more reliable ones, since, compared with the more reliable measure, the less reliable contains a larger proportion of errors of measurement. However, the validity or representativeness of the criteria must enter into the determination of their relative weights in the composite. A given measure may be highly reliable and consequently would be given a high weight but still be relatively unimportant in terms of measuring success because it is not highly representative. If the measures available are about equally representative of the job, then weighting them in terms of their reliability is a valid procedure.

TABLE 19.—INTERCORRELATIONS BETWEEN VARIOUS CRITERION MEASURES FOR DEPARTMENT-STORE SALESPERSONS

Criterion	Returns	Number of sales	Quota
Gross sales	0.58	0.47	0.65
Returns	....	0.01	0.32
Number of sales	....	....	0.24

Weighting According to an Assumed Underlying Variable of Job Success.—Another method for combining different measures of proficiency into a composite is based on the assumption that all the component measures are really indices of some single ability, or various aspects of a single ability, which underlies performance on the job.[17] In essence it is assumed that underlying all measures of success on a job there is a common factor. On the basis of this assumption it is argued that each measure should be weighted in proportion to how well it is correlated with this underlying common factor. It follows from this assumption that the intercorrelations between different criterion measures will necessarily be greater than zero, and for the assumption to be meaningful the intercorrelations should be at least moderately high. That these conditions are not always fulfilled may be seen from data presented by Stead and Shartle, which are reproduced in Table 19.[18] The average of these correlations is relatively low, being 0.38. It is to be noted that the correlation between gross sales and returns, possibly the two most important of the measures in the group, is only 0.01.

Multiple Cutoffs.—A final procedure involves a series of multiple cutoff points. For each measure of proficiency a minimum standard is set, and a worker who is above the standards on all measures of proficiency is deemed successful, whereas a worker who falls below the standard on *any one* or more of the measures is considered unsuccessful. On this basis workers are classified into two groups: the successful and the unsuccessful. With this procedure the point of view is adopted that, even if a worker is superior in all but one aspect of the job, his deficiency in the one aspect is not compensated for by his high achievements in the others. In other words, every single aspect of the job that is measured is considered essential, and failure in any one is tantamount to complete failure.

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CHAPTER IV

RATING METHODS

It has been shown that several aspects of job and worker analyses and of criterion measures of job proficiency require that specified individuals arrive at certain conclusions on the basis of their observations and express these opinions in a quantitative manner on some kind of scale. Thus in worker analysis the analyst studies the nature and characteristics of jobs, judges the requirements of these jobs, and attempts to set down his judgments in terms of the degree of importance of various traits, abilities, and skills. Similarly, on the basis of observation of workers and the products of their work, supervisory personnel arrive at certain conclusions concerning the caliber of the workers, and render quantitative estimates relative to their merit. This process of evaluation is termed *rating*. Since ratings are expressions of opinion they will be subject to all the errors characteristic of human judgments. It is necessary, therefore, to consider the most common kinds of errors and to evaluate means for overcoming or minimizing these errors.

THE RELIABILITY OF RATINGS

Determining Reliability of Ratings.—The reliability of any measuring device is determined by observing the degree of consistency of independent and comparable applications of the instrument. In order to achieve independence of ratings it is necessary that the ratings be made by different individuals. Successive ratings made by the same individual cannot be considered independent, inasmuch as personal biases or any other constant error influencing the first set of ratings would be likely to influence the second set of ratings. In addition the factor of memory prevents the successive ratings made by the same individual from being truly independent. It is apparent, therefore, that the reliability of ratings must be determined by observing the degree of consistency of ratings made by different individuals. This does not mean that the consistency of ratings made by a single individual is an unimportant consideration. Obviously, if a person is not self-consistent in his ratings of the same persons or things, his ratings will not be consistently related to those made by another individual.

Insofar as the factor of comparability is concerned, the problem is more difficult. Particularly in the evaluation of workers it is difficult to secure ratings by two or more individuals who have had equally good opportunities to observe the workers. Ordinarily the quality of the work of a group of employees is best known by their immediate supervisor, while the knowledge of their effectiveness as gained by supervisors at higher levels generally is fragmentary and superficial. Only if all supervisory personnel concerned are equally familiar with the workers and their activities can their ratings be considered comparable.

The Basis of Unreliability of Ratings.—Considerable evidence has accumulated relative to the causes of disagreement among raters.[1] The indication is that raters disagree primarily because they observe the individuals to be rated in different situations and under different conditions, and because they use different criteria for judging the same trait or characteristic. It follows from this evidence that reliability of ratings can be considerably increased by having the raters observe the individuals under similar situations, and by providing techniques for making the ratings that will increase the likelihood that the traits or characteristics being judged will be evaluated on the same bases.

TYPES OF ERRORS MADE IN RATINGS

Ratings and rating procedures have been the subject of considerable study. As a consequence the major types of errors made by raters are well known. We shall here discuss constant errors, the halo effect, and logical errors.

Constant Errors.—Inspection of sets of ratings made by different persons will reveal certain individual tendencies on the part of some raters to differ from other raters in a constant manner. Thus by clustering their judgments at the high end of the scale some raters tend to give higher ratings than most others. Other raters may cluster their ratings on some other portions of the scale. The two errors of this sort that are most frequently encountered are the *leniency error* and the *error of central tendency*. The leniency error refers to those situations in which the rater tends to assign high ratings to most individuals. Those raters who tend to avoid rating individuals either very high or very low, and whose ratings tend to cluster closely around the average or central point on the scale, are said to be subject to the error of central tendency.

In Fig. 7 are shown the ratings of seven persons, made by each of three raters. Although there is fairly good agreement among the three raters as to which individuals are relatively the best and which the poorest, the absolute ratings vary markedly. Thus individual A, who all raters agree is the best of the seven individuals, is rated 11 by rater I, 8 by rater II, and 12 by rater III. Rater I shows no marked constant errors, since his ratings are distributed almost throughout the entire scale. By contrast, the ratings of each of the other two judges are closely grouped. Rater II has clustered his ratings closely around the average point on the scale, whereas rater III has clustered his at the high end of the scale. Rater II shows the error of central tendency, and rater III the leniency error.

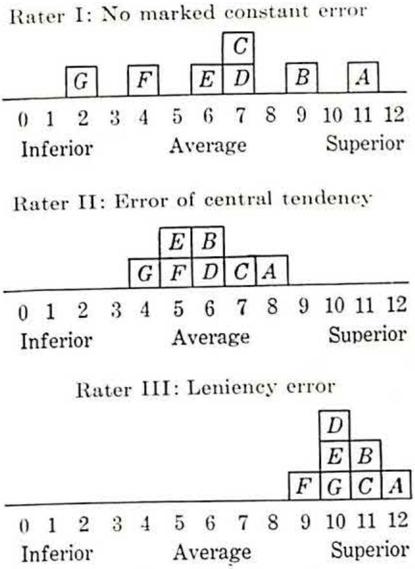

FIG. 7.—Examples of constant errors in ratings of seven individuals as made by each of three raters.

The Halo Effect.—A further error into which many raters fall is the halo effect. By halo effect is meant the influence that a rater's general impression of an individual has upon his ratings of that individual on specific traits. In other words, ratings on some particular characteristic of an individual are contaminated by the rater's notion of the general worthiness of the individual. Thus a worker who is judged by a supervisor to be generally unsatisfactory will be rated low on all aspects of his job performance, even though he may be truly satisfactory in at least a few aspects. Similarly, another worker who, on the whole, is believed to be slightly better than average, will be given ratings slightly above the average on all phases of his job performance, even though he may actually be deficient in certain phases.

The ratings of two insurance salesmen made by two different sales managers are shown in Table 20. Both salesmen were rated on an 11-point scale for each of five characteristics. The sales managers agree on the superiority of salesman A, but sales manager II has made a more discriminating analysis of the salesmen by indicating in his ratings their relatively strong and weak points. The ratings of sales

TABLE 20.—RATINGS OF TWO INSURANCE SALESMEN MADE BY TWO DIFFERENT SALES MANAGERS, SHOWING THE HALO EFFECT IN ONE SET OF RATINGS (SALES MANAGER I)

Job performance	Sales Manager I		Sales Manager II	
	Salesman A	Salesman B	Salesman A	Salesman B
Ability to sell new policies	8	3	9	1
Ability to obtain renewals of policies	8	3	6	4
Quality of services to clients	7	3	5	3
Quality of services to firm	8	3	5	2
Over-all value to firm	8	3	7	2

manager I are uniform for each salesman and clearly show the halo effect.

Since a rater who is subject to the halo error tends to give uniformly the same rating to each individual on all characteristics rated, the intercorrelations among the ratings are quite high. In Table 21 are given the intercorrelations among ratings on several traits that were made by the forelady of 26 inspector-packers of biological materials.

TABLE 21.—COEFFICIENTS OF CORRELATION BETWEEN RATINGS OF 26 GIRLS ON FIVE ASPECTS OF THE JOB OF INSPECTOR-PACKER OF BIOLOGICALS, AS MADE BY A FORELADY

Job aspects rated	2	3	4	5
1. Stoppering	0.91	0.60	0.85	0.80
2. Examining	....	0.86	0.70	0.94
3. Labeling	....	....	0.91	0.89
4. Packaging	....	....	....	0.95
5. Filling				

It will be observed that the correlations among the traits are consistently high. This means that the order of individual differences is approximately the same on all the traits.

Logical Errors.—Examination of a table of intercorrelations among ratings on different characteristics often reveals clusters of high coefficients among certain groups of traits. This state of affairs usually is due to the fact that raters tend to give similar ratings on traits or characteristics that seem to them to be logically related. For example, suppose a rater is judging the characteristics of several jobs and strength is one of the primary requirements to be rated. If, in one job, he overemphasizes this factor of strength as a result of his logical analysis of the job requirements, he then will tend to rate too high all the characteristics of this job in which strength is a component. If he considers that for another job only a moderate amount of strength is necessary, he will tend to assign average strength ratings to all the characteristics that involve this factor. If now he compares the characteristics of the two jobs in terms of the importance of the strength factor, he is bound to obtain a distorted relationship. Obviously the result will be high correlations among the ratings on the importance of the various strength factors, but the coefficients will be higher than is warranted because of the introduction of this spurious effect in the individual ratings. The tendency for ratings to be distorted in this manner has been called the *logical error*.[2]

CLASSIFICATION OF RATING METHODS

There is no easy way of classifying all the various kinds of rating procedures that have been devised. As a working classification there may be distinguished three major types, as follows: methods that do not attempt to take into account the size of absolute differences between the individuals rated, methods that provide scales for indicating absolute differences, and check-list methods that contain a series of scaled behavior descriptions.

Ranking Methods.—The first major type yields a ranking or ordering from best to worst of all individuals comprising the group. The rater simply picks out the individual he considers best, the one he considers next best, and so on, and ranks them in order.

Rating-scale Methods.—Rating methods that provide some sort of a scale may be classified into scales of discrete categories and graphic or continuous scales. In the scales of discrete categories, two or more categories are provided, representing different amounts of ability or degree of success. The person doing the rating checks the category that he feels best characterizes the person being rated. With graphic rating scales, similar categories are provided, but the rater, instead of having to check one or another of the categories, is provided with a straight uninterrupted line placed just above the category notations on which he indicates his rating by means of a check. The check need not correspond exactly with any of the reference points or category notations under the line but may be placed at any point along its length. The rater is able then to vary his rating somewhat from the category notations provided. On some graphic rating scales only the extremes and midmost categories are indicated rather than a large number of categories.

Rating scales may also be classified in terms of the kind of standards or categories used. On some scales the rater simply checks a number as the indication of the amount of the trait he believes the ratee possesses, while on others he may check one or another of a series of descriptive adjectives or graded samples of descriptions of behavior.

Check Lists.—Finally there are procedures that furnish the rater with a check list of prescaled descriptions of behavior. The scale values of the behavior items are unknown to the rater, and the task presented to him is to check all the items that he believes describe the worker being assessed. A final rating or score is obtained by averaging the scale values of the items he has checked as describing the worker.

RANKING METHODS

The primary advantage of rating individuals by arranging them in order of merit is simplicity; hence this method is to be advised for use in situations where the raters are unfamiliar with the problems involved in the use of rating methods. There are, however, two major difficulties. First of all, the task of ranking a group of individuals becomes difficult when there are over twenty or thirty cases. Secondly, the magnitude of the differences in ability between ranks is not equal at different positions. For instance, the difference in ability between the fifth and sixth individuals may be much greater, in absolute terms, than the difference between the sixth and seventh; yet in terms of rank the differences between these individuals are considered the same. If the group consists of a relatively few individuals, and the only requirement is to learn which ones are the better or which ones are the poorer, regardless of absolute ability, then the simple ranking method may well suffice. With large groups about whom some notion of absolute ability is important, some other method should be used, such as the rating scale.

Aids to Ranking.—When the number of individuals to be evaluated is large, one of several methods may be used to reduce the labor of ranking. Each rater may simply assign all individuals into two or more groups, roughly classifying them as "good," "average," or "poor," and then separately ranking the individuals in each group. After possibly a few shifts of cases borderline between groups, the rankings of the three groups are combined.

Since it is easier to judge which of two men is superior than to arrange members of a large group of workers in order of excellence, the *method of paired comparisons* sometimes is used. In this method the rater compares each man in the group with every other man. The final ranking of the workers is determined from the number of times each was judged better than the others. Although the ease of judging is probably greater, the amount of work that the judge must perform is greatly increased. The judge must make $n(n - 1)/2$ judgments, where n is the number of men to be ranked. Thus, if there are 50 men in the group, the judge must make 1,225 separate comparisons.

Transmuting Ranks to Values on a Continuous Scale.—Ranks are ordinal numbers; *i.e.*, they are numbers that indicate the relative position of an individual with respect to others in a group. The rank of an individual tells *how many other persons* he is better or poorer than, but it does not tell *how much* better or poorer he is than the other members of the group. Because ranks are ordinal numbers, they cannot be arithmetically manipulated, as can numbers representing points on a continuous scale, such as amount of test intelligence, number of items produced per day, or accident rate per year. Consequently, when a group of workers has been ranked by several supervisors, the final rank of each worker cannot be taken as the arithmetic average of all of the ranks assigned to him unless certain assumptions are made. If some average is required, the median, *i.e.*, the midmost rank, should be used.[3]

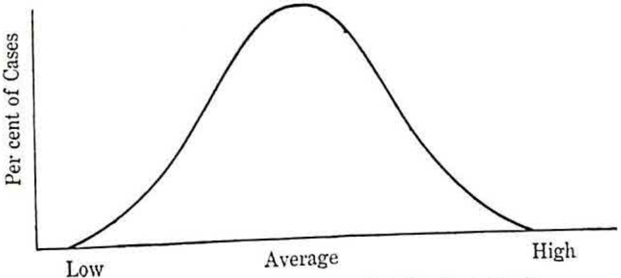

FIG. 8.—Normal frequency-distribution curve.

Because of the ordinal nature of ranks and the difficulties involved in handling them arithmetically and statistically, several methods have been suggested for transmuting ranks into values on a continuous scale.[4] In general these methods are based upon the assumption that any characteristic of human beings that is measured on a quantitative scale will be distributed in accordance with the normal distribution curve. A distribution of this type is shown in Fig. 8. If an ability under consideration is normally distributed, then the differences in absolute amount of ability between individuals at the extremes, whether high or low, will be greater than the differences in absolute amount of ability of individuals in the middle portions of the distribution. By way of illustration, the spacing of 15 individuals along a continuous scale, assuming a normal distribution of ability, is shown in Fig. 9. The marked differences between ranks at different points on the scale are very apparent.

On the basis of the mathematical relationship existing between ranks and scores on a continuous scale, assuming a normal distribution, tables have been prepared to facilitate the transmutation of ranks into scaled scores.[5] These scaled scores are so devised that the average is 50, and extreme values approach 0 and 100. A table of this kind is presented in Table 22. In effecting the transmutation the following formula is employed:

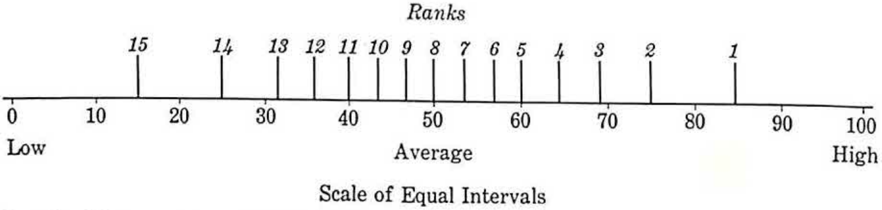

FIG. 9.—The spacing of 15 individuals along a scale assuming a normal frequency distribution.

$$\text{Per cent} = \frac{100(R - 0.5)}{N}$$

where per cent gives the percentage position, R the rank of the individual under consideration, and N the number of individuals being ranked. Thus the percentage position of the second ranking person in a group of 10 would be

$$\text{Per cent} = \frac{100(2 - 0.5)}{10}$$

$$= 15$$

Looking at Table 22, we find that a scale value of 70 is obtained for a percentage position of 15. This value, 70, would be this individual's score on a continuous distribution, assuming that a normal distribution holds within the group of ten individuals for the characteristic according to which they were ranked.

Although it is true that many physical and psychological characteristics are found to be distributed normally in the general population, it certainly does not follow that all characteristics in a specially selected

TABLE 22.—TABLE BASED ON THE NORMAL FREQUENCY DISTRIBUTION CURVE FOR TRANSMUTING PERCENTAGE POSITION IN A RANKED SERIES INTO VALUES ON A CONTINUOUS SCALE

Per cent position	Scale value	Per cent position	Scale value
1	93	51	50
2	89	52	49
3	86	53	49
4	84	54	48
5	82	55	48
6	80	56	47
7	79	57	47
8	78	58	46
9	76	59	46
10	75	60	45
11	74	61	44
12	73	62	44
13	72	63	43
14	71	64	43
15	70	65	42
16	69	66	42
17	69	67	41
18	68	68	41
19	67	69	40
20	67	70	40
21	66	71	39
22	65	72	38
23	65	73	38
24	64	74	37
25	63	75	37
26	63	76	36
27	62	77	35
28	62	78	35
29	61	79	34
30	60	80	33
31	60	81	33
32	59	82	32
33	59	83	31
34	58	84	30
35	58	85	30
36	57	86	29
37	57	87	28
38	56	88	27
39	56	89	26
40	55	90	25
41	54	91	23
42	54	92	22
43	53	93	21
44	53	94	20
45	52	95	18
46	52	96	16
47	51	97	14
48	51	98	11
49	50	99	7
50	50		

group will be distributed in this manner. As a matter of fact it is unlikely that a trait such as speed of work would be normally distributed in a highly skilled group of workers. One would expect that through a process of selection, elimination, and training, there would be a large number of "high" persons and a small number of "low" persons, a considerable variation from the normal distribution. Such a nonnormal distribution is shown in Fig. 10. For a distribution of this type the spacing of individuals along a scale would be like that shown in Fig. 11. It is apparent that the differences in absolute amount of ability are greater between persons at the low end of the scale than between those at the high end, and that the smallest differences occur in a region just above the average.

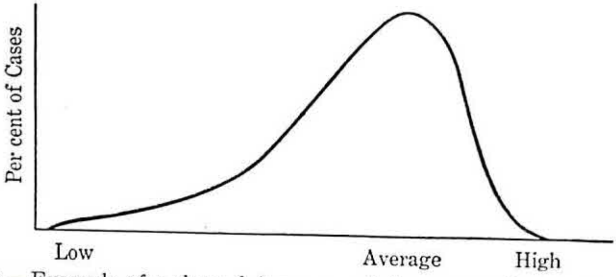

FIG. 10.—Example of a skewed (nonnormal) frequency-distribution curve.

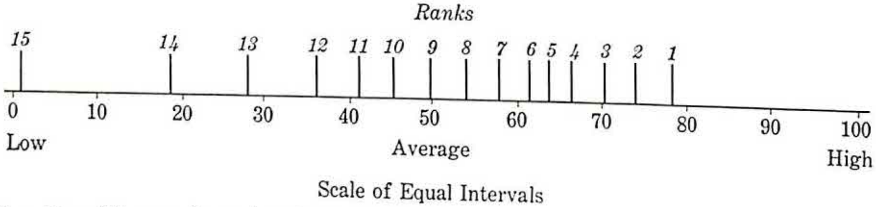

FIG. 11.—The spacing of 15 individuals along a scale of equal intervals assuming a distribution skewed as in Fig. 10.

In view of the fact that for any group of workers the shape of the distribution of the trait on which the workers are to be ranked will be unknown, the transformation of ranks into values on a continuous scale will introduce an error of unknown extent. As a consequence, such transformations must be applied with caution.

Group-order Rankings.—In many instances a complete ranking of all individuals in order of merit is not necessary. Sometimes what is desired is to know in which half, fifth, seventh, etc., of his group a person belongs. In this instance the group of workers is divided into whatever proportions appear to be desirable. Ratings of this kind are termed *group-order rankings* and are illustrated in Fig. 12.

Over-all rating: consider both the individual's success as a casualty insurance agent and his loyalty to the X company. When making this judgment, keep in mind all the X company's agents. The phrases below were chosen to aid in describing successive fifths of all casualty agents in general job success. Therefore 20 per cent of the agents should be placed under each heading.

Highest fifth	Next highest fifth	Middle fifth	Next lowest fifth	Lowest fifth
Outstanding, among best agents in the company	Superior, above average but not outstanding	Average, neither superior nor inferior	Below average but not poor	Falls among the poorest agents in the company

FIG. 12.—Example of group-order ranking procedure.

When the group-order method is used, it is customary to assign a series of numbers or letters to the categories. If the group is divided into fifths, those in the lowest fifth are assigned a rating of 1, and those in the highest fifth a rating of 5, with the intermediate categories being assigned appropriate numbers between 1 and 5. These final ratings are then treated as if they were values on a continuous scale. Although this may be satisfactory for rough work, as pointed out earlier, such a procedure in the treatment of ordinal numbers is not logically sound.

To overcome this deficiency the proportion of individuals assigned to each group may be allotted in accordance with the normal distribution curve. By having larger numbers of persons assigned to those groups in the central positions and fewer to the extreme groups, an approach to the normal distribution can be achieved. If this procedure is accurately carried out, the differences between successive groups, in terms of the ability under consideration, can be considered to be equal. In effecting this type of grouping the total range of individual differences is divided into whatever number of categories is desired, and frequencies are set up for each category in accordance with the normal frequency distribution. Table 23 gives appropriate proportions for dividing a normal population into varying numbers of steps. Since the effective range of individual differences is greater when the number of persons in the distribution is larger, separate frequencies have been presented for situations where 20, 40, and 60 individuals are to be rated. An example of a rating form employing this principle is shown in Fig. 13.

Rate each of the clerks in your department on the following characteristics. Rate all of them on the first characteristic, Amount of Output, then rate all of them on the second characteristic, Quality of Output, etc. Assign the ratings as follows:

A = 7 per cent
B = 25 per cent
C = 36 per cent
D = 25 per cent
E = 7 per cent

These percentages must be adhered to as closely as the number of clerks you are rating will permit. For each characteristic enter all names in the appropriate spaces provided.

	E	D	C	B	A
Amount of Output					
Quality of Output					
Accuracy					
Punctuality					
Initiative					
Interest					

Fig. 13.—Rating scale for clerical workers, employing the group-order method of ranking, with proportions distributed among the groups in accordance with the normal frequency distribution.

In an earlier discussion concerning the transformation of ranks into values on a continuous scale, the problems involved in the assumption of a normal frequency distribution were considered. The same limitations hold in the assumption of this type of distribution when assigning the frequencies to successive groups in the group-order ranking method.

Table 23.—Percentage of Cases Expected on the Basis of a Normal Frequency Distribution to Fall into Each Step on Rating Scales of Varying Numbers of Steps

	Number of intervals																				
	3			4			5			6			7			8			9		
No. of cases to be rated	20	40	60	20	40	60	20	40	60	20	40	60	20	40	60	20	40	60	20	40	60
Steps in scale	Per cent																				
1	25	21	20	14	12	10	9	7	5	8	5	5	6	4	4	5	3	2	4	3	2
2	50	58	60	36	38	40	24	25	26	16	16	15	11	11	10	9	8	8	7	6	6
3	25	21	20	36	38	40	34	36	38	27	29	30	20	21	22	15	16	16	12	12	12
4				14	12	10	24	25	26	27	29	30	26	28	28	21	23	24	17	18	19
5							9	7	5	16	16	15	20	21	22	21	23	24	20	22	22
6										8	5	5	11	11	10	15	16	16	17	18	19
7													6	4	4	9	8	8	12	12	12
8																5	3	2	7	6	6
9																			4	3	2

Evaluation of the Ranking Method.—As has been indicated, the primary characteristic of the ranking method is its simplicity. For persons who are untrained or inexperienced in the problems of rating it would seem to be about as effective as the more refined rating techniques. Since, in ranking, all individuals are ordered in a sequence, constant errors in rating do not enter. Although there is no direct information insofar as the halo effect and logical errors are concerned, it would appear that they are present in rankings to a considerable extent, since the basis of the decisions relative to the placement of the individuals is left solely to the person doing the ranking. This procedure would permit markedly varying policies between different raters.

RATING SCALES

Types of Rating Scales.—As indicated at the beginning of this chapter, there are two general types of rating scales: scales of discrete categories and continuous or graphic scales. The difference between the two types of scales is that the former presents a series of discrete steps to the raters, whereas the latter presents a continuum. The standards used are the same for both types of scales, such as a series of numbers or descriptive adjectives. The advantages and disadvantages of these different types of standards will be discussed below, and the conclusions drawn will hold for both types of scales. It is said that the continuous rating scale has some advantage over the scale of discrete categories in that it does not compel the rater to force each individual into one or another of a relatively few categories. This problem is allied to the number of steps or categories used in discrete scales, a matter that will be discussed later. Examples of various types of rating scales are shown in Fig. 14.

Cooperativeness: consider the man's ability to work smoothly and well with others

0 1 2 3 4 5 6 7 8 9 10

Tact in dealing with people

____ Excellent
____ Good
____ Average
____ Poor
____ Inadequate

Alertness

Very slow in grasping the meaning of things, misunderstands questions	Fairly slow in grasping the meaning of questions or statements	Quick in producing ideas and understanding questions	Exceptionally keen and alert

FIG. 14.—Examples of rating scales.

In arriving at a quantitative rating, when scales of discrete categories are used and the categories themselves are not numerical, a series of numbers are arbitrarily assigned to the categories. Thus, in a scale employing four descriptive adjectives such as poor, fair, good, and excellent, a person rated as poor would be given the quantitative rating of zero, a person rated as fair would be given a score of 1, and so on. In another example, a scale of eleven categories is employed, the lowest category being assigned the arbitrary value of zero, the next of 10, and so on to the top category, which is assigned the value of 100.

In continuous or graphic rating scales, a line, which usually is no longer than 5 in. or less than 2, is placed above the categories. If the line is too long the whole scale cannot be adequately grasped by the rater, whereas, if the line is too short, the rater will find difficulty in accurately measuring distances on it. In recording his rating the rater simply places a check mark at some point along the line. The check mark may be placed directly over any standard, or it may be placed at any point between two contiguous standards. In obtaining an individual's rating on a continuous scale, a ruler is placed below the line on which the check mark was made, and the length of the line from the lower end of the scale to the check mark is read off. The rating may be expressed in terms of the units on the ruler, such as millimeters, in terms of an arbitrary scale as from 0 to 10, or in terms of the percentage of the total scale distance that the check mark is separated from one extreme or the other.

Types of Standards Used in Rating Scales.—There are four general kinds of standards used in rating scales, viz., numerical or alphabetical, descriptive adjective, man-to-man, and behavior sample. In general the first two classes of standards are simple, and there is no problem in constructing them. The last two present more of a problem, particularly if they are to be constructed in an accurate manner.

1. *Numerical and Alphabetical Scales.*—With numerical rating scales a series of numbers is provided, which supposedly indicate the amounts of the characteristic being rated. For example, on a scale ranging from 0 to 10, if a person was judged to be of average ability, he would be rated 5, and if he were judged to be the best possible worker, he would be rated 10. Sometimes 0 is the value assigned to average ability, with a series of positive numbers indicating superior degrees of the characteristic being rated, and a series of negative numbers indicating inferiority of varying degrees. The major difficulty with numerical rating scales, and it is indeed a very serious one, is that the numbers which serve as standards are abstract; they bear no relation to reality. We do not naturally think of an individual as being 6 in quality of output, or −3 in promptness. The rater is therefore forced to provide for himself some meaning to the otherwise meaningless units. Thus there are apt to be marked discrepancies between different raters. One rater may feel that 10 indicates such a high degree of ability that only one person in ten thousand possesses it, whereas another rater might simply interpret such a rating as indicating a superiority of ability that is relatively common.

Similar to numerical scales are those which use a series of letters as standards. In a five-step scale the highest category might be *A* and the lowest *E*. There appears to be little difference between using numbers or letters as standards. Any deficiency in the one will certainly be found in the other.

2. *Descriptive-adjective Scales.*—Scales wherein a series of descriptive adjectives are used somewhat overcome the abstractness that is characteristic of numerical scales. The phrase "very superior" is probably more meaningful than the number 10. But even so, raters will differ in their interpretation of the descriptive adjectives, and thus the standards will not be the same for different raters. Data presented in Table 24 will serve as an illustration of the manner in which raters vary in their interpretation of descriptive adjectives. Fourteen adjectives used in various scales on which workers have been rated were presented in a randomized list to 34 persons.[6] These persons were told that each adjective described a worker, and on the basis of these adjectives they were to rank the 14 workers in order of merit. The percentage of judges assigning various ranks to each worker is shown. For example, 65 per cent of the group considered the worker who was described as "exceptional" as being the best of the 14, whereas 21 per cent considered the worker described as "superior" as being the best, and 15 per cent considered the worker described as "excellent" as being the best. Although in general those adjectives

TABLE 24.—PERCENTAGES OF 34 PERSONS ASSIGNING VARIOUS RANKS TO 14 DESCRIPTIVE ADJECTIVES WHEN THE ADJECTIVES ARE TAKEN AS RATINGS OF WORKERS

	Rank														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total, per cent
Exceptional	65	29	6	...	...	...	...	...	...	...	...	...	...	...	100
Excellent	15	44	41	...	...	...	...	...	...	...	...	...	...	...	100
Superior	21	26	53	...	...	...	...	...	...	...	...	...	...	...	100
Good	...	...	...	50	41	9	...	...	...	...	...	...	...	...	100
Competent	...	...	...	47	41	6	3	...	3	...	...	...	...	...	100
Satisfactory	...	...	...	...	6	62	24	3	...	...	6	...	...	...	101
Adequate	...	...	...	3	12	12	32	21	15	6	...	...	...	...	101
Average	...	...	...	...	...	6	26	44	12	6	6	...	...	...	100
Ordinary	...	...	...	...	...	3	6	15	50	24	3	...	...	...	99
Fair	...	...	...	...	...	3	9	12	18	26	29	3	...	...	101
Mediocre	...	...	...	...	...	...	...	6	3	32	44	9	3	3	100
Weak	...	...	...	...	...	...	...	...	...	3	9	71	15	3	101
Poor	...	...	...	...	...	...	...	...	...	...	3	6	59	32	100
Inadequate	...	...	...	...	...	...	...	...	...	3	...	12	24	62	101
Total, per cent	101	99	100	100	100	101	100	101	101	100	100	101	101	100	

obviously indicating superior performance were ranked high and those indicating inferior performance were ranked low, nevertheless there was considerable disagreement in the placement of the words. The worker described as "adequate" was ranked by some individuals as high as 4 and by others as low as 10.

The differences in amount of the trait or ability indicated by the distance between the standards should be equal; otherwise the scale will not be a scale in the true sense. A measure of linear distance, such as a foot rule, on which the first unit was made 1½ in. long, the second ¾ in., the third 2⅜ in., etc., would not be a scale with comparable units. On such a scale an object two units long could not be said to be twice as long as an object only one unit long. Similarly the difference in ability between two contiguous standards on a rating scale, such as "very superior" and "superior," might not be considered by the rater as being equal to the difference on the same scale between the two next contiguous standards, "superior" and "good." Little or no attempt has been made to find a series of adjectives that a large number of individuals agree indicate equal differences. Indeed one even encounters a reversal of the order of the same terms on different scales. On one scale "superior" might be the step above "average," and "good" the step above that; whereas on another scale "superior" might be placed above "good," the latter adjective being considered as indicating ability just above "average."

3. *Man-to-man Rating Scales.*—In the so-called "man-to-man" rating scales the names of actual individuals known to the rater are used as a series of standards. Originally the procedure in constructing a man-to-man rating scale was to have the prospective rater select 10 to 20 individuals of varying ability whom he knew well and have him rank them in the ability under consideration. The highest ranking man was used as the highest standard, the lowest ranking man as the lowest standard, the individual with the midmost ranking as the middle standard, and individuals equally ranked between the middle and extremes as the remaining standards. In rating another person the rater simply considers the individuals selected as standards and checks the one nearest in ability to the person being rated.

The foregoing procedure for the construction of the man-to-man rating scale is of course completely incongruous with the basic concept of what constitutes an adequate series of standards for a rating scale, since there is no assurance that the differences between ranks indicate equal differences in ability. The correct procedure is to have the prospective rater select a person of his acquaintance whom he considers average in the ability in question. Two other acquaintances are then selected, one of superior ability and one of inferior ability, the one being as much better than the "average" person as the other is inferior. The rater than selects a fourth acquaintance who is judged to be halfway between the average and the superior individual, and a fifth who is judged to be halfway between the average and the inferior individual. This procedure is continued until there are obtained as many comparison individuals as the number of standards desired. The procedure is likely to be difficult and laborious even for a rater of considerable experience, but it is necessary if a scale approaching equal intervals is to be achieved.

The obvious advantages of the man-to-man rating scales is that the standards are very concrete. They are in terms that even an untrained rater can understand; they are real. Besides the difficulty in construction there is a further disadvantage in the use of man-to-man rating scales in that the standards set up by different raters may not consist of the same individuals, and hence ratings by different judges will not be comparable. It is not to be expected that one rater can successfully use a man-to-man scale constructed by another.

4. *Behavior-sample Scales.*—Scales employing a graded series of samples of behavior as standards are potentially the most refined of all rating scales. The use of actual descriptions of behavior reduces some of the differences in interpretation of the standards usually found among different raters. On a rating scale for the trait "reliability" it is highly probable that the agreement among different raters on the meaning of the sample of behavior "observations and reading of instruments are always checked for accuracy and completeness" will be greater than for the phrase "very reliable" or for the number 5.

In the construction of behavior-sample rating scales the customary procedure is simply to write down a set of samples of behavior obviously describing individuals varying in ability. An individual who is very familiar with the problems of ratings, and who has had considerable experience in the construction and administration of rating procedures, will probably construct a very satisfactory behavior-sample scale using this procedure. For the inexperienced person the use of a systematic procedure will be of considerable aid in achieving the construction of an adequate scale. On the next page a procedure is outlined for securing standards for a behavior-sample scale that will yield standards more equally spaced psychologically and will be more uniformly agreed upon and understood.[7]

1. On the basis of interviews with supervisors and comments made by them about workers, a series of descriptions of the "best" worker are prepared.
2. These descriptions are submitted to the supervisors with the instruction that they are to pick out the one which best describes the "best" worker. If the extent of agreement among the supervisors is high, that description selected by them is retained as the highest step on the scale.
3. If there is little agreement among the supervisors relative to the descriptions, new descriptions are prepared and resubmitted to them.
4. A similar procedure is followed in developing a description for the "poorest" worker as the lowest step on the scale.
5. The supervisors are then presented with the two descriptions selected as the extreme steps and are asked to describe a worker exactly halfway between these two, *i.e.*, an average worker.
6. On the basis of these statements, descriptions of an "average" worker are prepared.
7. The best one of these is selected in the manner described above.
8. As many additional steps as appear desirable are developed, using the same procedure as that used for the "average" worker.

The Number of Steps in the Scale.—One important problem that always presents itself in the construction of rating scales involving discrete categories is the number of steps or standards to be employed. At present it would seem that no generalizations can be made which will apply to all scales. The best that can be done is to discover empirically the optimal number of steps for each scale. Either reliability of measurement or ease of rating may be used as a basis for the determination of the optimal number of steps.

Obviously, if the steps in a rating scale are very coarse, the raters' powers of discrimination cannot be effectively used. On the other hand, no advantage will be gained if the steps are finer than the ability of the raters to discriminate. In the first case the rating scale will not have its maximal reliability, and in the latter the scale will be refined beyond the point of maximal reliability. From a theoretical analysis, Symonds concluded that maximal reliability will be obtained when seven steps are used.[8] However, if the raters are untrained or relatively disinterested, maximal reliability will be reached with fewer steps. The results of an experimental investigation by Champney and Marshall on the relationship between the number of steps in a rating scale and reliability suggest that nine is the optimal number of steps for trained raters.[9] The number of steps yielding the highest reliability, however, probably will vary considerably with the nature of the trait being rated.

There has been much discussion but little actual investigation of the relationship between the number of steps in a rating scale and the ease with which the rater can employ it in the practical situation. The general conclusion is that the fewer the steps the less the difficulty experienced by the judge. Results obtained by Ghiselli, however, suggest that the reverse is true.[10] He found that there was greater willingness to express opinion on a four-step scale than on a two-step scale.

Guide Distributions.—When raters fall into the error of leniency or the error of central tendency, the result is that the lower part or the extremes of the scale are not used. To some extent this is due to the fact that the raters have no knowledge of how individuals should be distributed along a scale of ability. One solution is to provide the raters with a guide distribution, showing the expected proportion of cases that should fall in each category on the rating scale. If the raters are instructed to adhere strictly to these proportions, then of course a group-order ranking procedure is being employed rather than a rating procedure. In most cases, however, the expected distribution of cases is simply provided as an aid to the rater, and proportions such as those given in Table 23 are suggested. Ordinarily a normal frequency distribution is employed. The problems involved in assuming such a distribution have been discussed in connection with the group-order ranking procedure.

Mathematical Corrections.—In the chapter on criterion measures of job proficiency, the standard score procedure was outlined in connection with those situations where different groups of workers varied in the average and variability of their production. It was pointed out there that standard scores can be used to correct for these variations between groups of individuals. The same procedure has been employed to correct for the differences in the average and variability of ratings found for different raters.[11] This application of the procedure may be exemplified by means of the data given in Fig. 7. In that figure the ratings of seven workers made by each of three raters are shown to vary considerably. The average (mean) of the ratings for each of the three judges is, respectively, 6.6, 5.7, and 10.4, and the standard deviations 1.8, 1.5, and 1.1. Worker C was assigned a rating of 7 both by rater I and rater II, while he was rated 11 by rater III. From these crude ratings it might be concluded that worker C was considered to be of the same relative ability by raters I and II. If the ratings are transmuted into standard scores, quite a different picture appears. In terms of standard scores the ratings for worker C are: for rater I $(7 - 6.6)/1.8$ or $+0.2$; for rater II $(7 - 5.7)/1.5$ or $+0.8$;

and for rater III $(11 - 10.4)/1.1$ or $+0.5$. Thus, relative to all individuals rated, rater II gave worker C a higher standing than he was given by rater I.

By transmuting ratings into standard scores the final ratings of all raters will have the same average or mean and the same variability. In this manner all constant errors on the part of raters will be corrected. Conrad has reported that, with raters who have had some experience, corrections such as those described above do not appreciably increase the validity of combined ratings.[12]

POOLED VERSUS JURY RATINGS

In those circumstances where each worker is rated by more than one rater, it is commonly believed that, if the raters can discuss each case among themselves, their combined rating will be more accurate than a simple pooling of their individual ratings made independently. On the surface these jury ratings would seem to permit of greater accuracy than a simple pooling of independent ratings. Although this problem is of considerable importance, it has not received thorough experimental study. A survey by Rusmore of those studies having some bearing on the matter suggests that group judgments are somewhat more accurate than pooled independent ratings, and that in addition they reveal more information about the person rated.[13]

Rusmore attempted to study the effectiveness of jury ratings as compared with pooled independent ratings in a situation closely parallel to the industrial situation.[14] He had 86 persons rate the skill of 12 operators performing an industrial task. Although these raters were inexperienced, they had had some instruction in rating procedures. Each rater made his judgment independently, and then again after discussion in small groups, the latter rating being the consensus of the group. The accuracy of the ratings was determined by correlating the ratings with measurements of the actual speed and accuracy of the workers who were observed. The coefficient of correlation between the pool of independent ratings and actual performance was 0.84, while the similar coefficient for the jury ratings was only 0.77. The results of this investigation indicate that the jury ratings are not superior to the pool of independent ratings and even may be slightly inferior.

MULTIPLE RATINGS ON SPECIFIC ASPECTS OF JOB PERFORMANCE

When rating scales first came into popular use as instruments for measuring the effectiveness of human performance in some particular job, the usual method was to rate each individual on the single characteristic of general worthiness. By and large, the reliability of these over-all ratings was rather low, a coefficient of 0.50 being about the highest. In seeking to improve the dependability of these ratings, efforts were directed toward changing the physical aspects of the scale, of more carefully defining the steps, etc. More recently the tendency has been to analyze the job into its important components and to prepare a separate scale for each component. An individual's over-all rating is taken as the average or sum of the ratings on the specific aspects of the work. In some cases the separate scales are given different weights in the determination of the final composite rating.

Ratings of Specific Aspects of Performance versus Over-all Ratings. One problem that should be considered is whether more dependable information can be obtained from average or total ratings on a series of scales designed to measure success in specific aspects of the job, than from a single scale of over-all job excellence. The available evidence is fragmentary, and facts are available on only a few types of jobs.

Three investigations carried out by the U.S. Employment Service are relevant to the present problem.[15] In one study a group of department-store salespersons were rated by two superiors on ten specific aspects of job performance, such as knowledge of merchandise, sales talk, ability to satisfy customers' needs, etc. The coefficients of correlation between the two judges' ratings on the ten specific scales ranged from 0.05 to 0.28, with a mean of 0.16. When the ten ratings by each judge for each salesperson were averaged, the coefficient of correlation between the average ratings of the two judges was found to be 0.32. In addition to these specific ratings, the two superiors rated each person on an over-all rating scale of general job success. The coefficient of correlation between the over-all ratings of the two judges was 0.58. These findings indicate that the reliability of ratings on any specific aspect of job performance may be expected to be considerably lower than that of an over-all rating and furthermore the reliability of the average of such specific ratings is somewhat below that for the over-all rating.

These conclusions, in part, are substantiated by another investigation of the U.S. Employment Service, which was carried out with a group of cafeteria counter workers, where each employee was rated by three judges on two different occasions. The employees were rated on 12 different scales of specific aspects of job performance, such as ability to suggest items to customers, economy in handling foods, speed of movement, and also an over-all rating of general value was made. The coefficients of correlation between the ratings of pairs of judges on the specific aspects of the work ranged from −0.09 to 0.56, with an average of 0.37. The coefficient of correlation between the average ratings on the specific scales of pairs of judges ranged from 0.32 to 0.62, with an average of 0.56, which is insignificantly different from the reliability of 0.58 obtained for the over-all ratings.

The results for the repeat ratings showed the same trend. In this case each judge's ratings on the first occasion were correlated with his ratings on the second occasion. The coefficients of correlation between the two sets of ratings for the scales of specific aspects of job performance ranged from 0.17 to 0.96, with an average of 0.52; the coefficients of the composite of these specific ratings ranged from 0.82 to 0.92, with an average of 0.84. The coefficients for the over-all ratings ranged from 0.77 to 0.83, with an average of 0.80.

A third investigation made by the U.S. Employment Service may be cited to show the interchangeability of over-all and specific ratings. In this study, interviewers working in state employment services were rated twice by two judges on a number of scales designed to measure success in specific aspects of the job and also on an over-all rating scale. The reliability of the composite of the specific ratings on the first occasion was found to be 0.76, and on the second, 0.71. The coefficient of correlation between the over-all ratings and the composite of the specific ratings on the first occasion was 0.70, and on the second occasion, 0.71. It may be said, therefore, that a composite of ratings on specific aspects of the work correlates about as highly with an over-all rating as the composite correlates with itself.

One final investigation may be described that again demonstrates the fact that an average of ratings of specific aspects and over-all ratings are measuring the same thing. Ghiselli had the supervisor of a group of casualty insurance salesmen rate the salesmen on what were considered the four major aspects of the work, viz., ability to obtain new accounts, ability to obtain renewals of expiring policies, willingness to perform services (such as adjustment) to the company, and ability to perform services (such as explanation of policies) to the policy holders.[16] In addition, the sales manager rated the men on an over-all scale of general success on the job. The coefficient of correlation between the average of the specific ratings and the over-all ratings was 0.85. This means that the order of individual differences among the salesmen on the over-all ratings was just about the same as the order on the composite of the specific ratings. It took the sales manager some 3 hr. to rate the group of salesmen on the specific traits, whereas the over-all scale rating required only about ½ hr.

Bingham has suggested that, in order to have adequate reliability, over-all ratings must be made *after* the rater has first rated on scales of specific aspects of the job.[17] This suggestion is made because if a rater simply makes a general judgment of an employee's value to an organization without first analyzing his specific defects and superiorities, the over-all judgment will be undependable. To examine the validity of Bingham's argument would require a situation where one judge rated the employees on specific aspects of the work and another made over-all ratings. By this means, if the ratings of the two judges were done independently, one type of rating could not be said to affect the other. Ghiselli investigated just such a situation with inspector-packers in a pharmaceutical manufacturing plant.[18] In this case the job was broken down into five specific aspects of the work, such as examining, labeling, stoppering bottles, etc. The forelady rated every girl on scales measuring each of these important aspects of the work, and the supervisor rated them on an over-all scale of general value to the organization. The coefficient of correlation between the average ratings of the forelady and the ratings of the supervisor was found to be 0.73. This coefficient indicates that the two types of ratings, although made independently, are fairly similar. More evidence is necessary on this point, however, before any final conclusions can be drawn.

The Weighting of Ratings of Different Aspects of Job Performance. In the chapter on criterion measures of job proficiency it was pointed out that, when a number of different measures of success on a job are provided, the problem arises of weighting each of them optimally before combining them into a final measure of proficiency. A similar problem arises when workers are rated on a number of different aspects of their performance on the job, for example, when a form such as that shown in Fig. 13 is used. Ordinarily the weights assigned to the various scales are set on the basis of judgments by persons familiar with the job. The various methods for combining criteria discussed earlier can also be employed in determining the best possible way for combining several ratings.

The first consideration is whether the differential weighting of the various items on the rating form has any effect. If all scales were given the same weight rather than different weights, and if the order of individual differences among the workers in terms of final ratings remained unchanged, then it could be said that the differential weighting adds no improvement to the measurement. The coefficient of correlation between final ratings, when the items are equally weighted, and the final ratings when the items are differentially weighted provides the necessary index. If the coefficient is very high, then the weighting system adds nothing, whereas, if it is moderate or low, the weighting system can be said to be important.

It can be shown mathematically that this coefficient becomes higher under the following conditions: the greater the number of traits being rated, the higher the intercorrelations among ratings of the different scales, and the more similar the weights (as, for example, weights of 4, 5, 6, and 7 as compared with weights of 1, 4, 7, and 10). In most instances where ratings are used, the conditions are such that application of differential weights to the different scales will have little effect. For example, with a set of only four scales, with intercorrelations of approximately 0.50 (a figure typical for ratings), and weights as disparate as 1, 4, 7, and 10, the coefficient of correlation between the final composite, based on differential weights, and the final composite based on equal weights, will be 0.97. Since most rating forms employing more than four scales have intercorrelations among ratings which average about 0.50 and weights which usually are less disparate than those given in the example, it can be concluded that differential weighting of the various scales will have little effect in changing the results compared to an equal weighting of the scales.

A second consideration has to do with the range of ratings on the different scales. Ordinarily it is found that on a rating form containing a number of different scales the ratings on some scales cover many more steps than the ratings on other scales. In the final composite rating those scales with the greatest variation in ratings carry the most weight. This can be shown very simply. Suppose a group of workers was rated on two characteristics—speed of production and quality of output—each set of ratings being made on a scale ranging from 1 to 5. Suppose that some workers were given ratings as low as 1 on speed of production and others were rated as high as 5; however, on quality of output all workers were given the rating of four. When the final rating is computed for each worker by adding his ratings on the two scales, it can be seen that the rating on quality of output will have no differential effect upon the composite ratings, since it is simply a constant number added for each worker to his rating in speed of production. The extent of variation of the different traits can be measured by the magnitude of the standard deviation of the ratings, the larger the standard deviation the larger will be the weight carried by that scale in the final composite rating. In Table 25 are shown the standard deviations of the ratings of 1,000 steel-mill workers on each of 12 traits.[19] The ratings on safety had the least variability and hence carried the least weight in the composite, while the ratings on health had the widest variability and hence carried the greatest weight.

TABLE 25.—STANDARD DEVIATIONS OF RATINGS OF 1,000 STEEL WORKERS ON 12 TRAITS

Trait	Standard deviation	Relative weight
Safety	2.24	100
Knowledge of the job	2.77	124
Versatility	2.88	129
Accuracy	2.69	120
Productivity	2.58	115
Over-all job performance	2.63	118
Industriousness	2.96	132
Initiative	3.08	138
Judgment	2.68	120
Cooperation	2.72	122
Personality	2.51	112
Health	3.14	140

Obviously, when only one or two steps on a scale are being used by the rater, individual differences are not being measured, and that particular scale is not serving a useful purpose and therefore should not be used in getting a composite rating. Methods for computing the weight to be assigned to the rating of any scale, before combining it with others to form a composite, are similar to those discussed for criteria and will not be reproduced here.

CHECK LIST OF SCALED ITEMS

Construction of Check Lists.—A number of years ago Thurstone devised a technique for the measurement of attitude that was based on the older psychophysical method of equal-appearing intervals.[20] This technique yields a series of scaled statements of beliefs or attitudes relative to some particular subject, and an individual simply checks those items with which he agrees. These items have been previously assigned scale values in terms of the degree to which each is considered a favorable or unfavorable opinion relative to the issue in question. The measurement of the individual's attitude is taken as the average scale value of those items he checks.

As was pointed out at the beginning of this chapter, ratings are simply a quantification of opinion. It is apparent, therefore, that Thurstone's method can be adapted as a means for developing a procedure for the rating of workers by their supervisors. Following are the steps involved in the preparation of a rating form using the technique of equal-appearing intervals.

1. The job is analyzed in order to provide a guide concerning the major areas in which success should be measured. Some notion relative to the importance of each of these areas should also be obtained. This step is necessary, first of all, as a basis for the collection of items and, secondly, as a means for checking the coverage of the job by the final scale.

2. A series of statements concerning the performance of individuals on the job is collected. The best source of such statements will be the reports made by supervisors on their workers. These reports may be in the form of comments made by supervisors on rating scales or other formal evaluations. Additional items may be collected through informal conferences with the supervisors, wherein they are asked to describe in specific terms the performance of various workers. Examples of items from a rating form for salesmen are given in Table 26,[21] and for a rating form for waitresses in Table 27.

TABLE 26.—EXAMPLES OF ITEMS CONTAINED IN A RATING FORM FOR SALESMEN

Scale Value	
29	____ He is weak on planning
32	____ He is somewhat in a rut on some of his brand talks
46	____ He is a good steady worker
56	____ He tends to keep comfortably ahead on his work schedule
69	____ He is making exceptional progress

TABLE 27.—EXAMPLES OF ITEMS CONTAINED IN A RATING FORM FOR WAITRESSES

Scale Value	
13	____ Slow and clumsy
22	____ Is impatient while taking orders
26	____ Gets rattled when rushed
36	____ Does no more than is necessary
39	____ Works slowly and methodically
57	____ Neat in appearance and work
65	____ Cheerful disposition, doesn't get annoyed at customers

3. Items are eliminated or edited to ensure that they are (1) short and specific, (2) to the point, (3) not double-barreled, but can be either accepted or rejected and (4) related to successful performance on the job as indicated by the job analysis.

4. A number of competent persons are asked to evaluate each of the items on a scale relative to the degree of job success a worker so described would have. Ordi-

narily a numerical rating scale of five to nine steps is provided for the judges, and every judge rates each item on this scale.

5. The scale value of each item is obtained by taking the average of all the judges' ratings of it. The items in the scale for salesmen, shown in Table 26, and for waitresses in Table 27 were evaluated on a scale of seven steps, the lowest being given the value of 10 and the highest, 70. In using the final scale the scale values are not given on the form and are unknown to the rater.

6. Those items on which the judges show wide disagreement in their ratings obviously are ambiguous and have different meanings for the various judges. Items of this sort are discarded, and only items on which there is a high degree of agreement are retained. In Table 28 are the judgments on two items of 25 individuals who were asked to scale a number of items dealing with the job of waitress. For the first item, "Fast, but makes mistakes in orders," there was low agreement among the judges as to the type of worker it described. Three judges rated the item 10, indicating that they believed it described the poorest type of waitress, whereas two other judges rated it 50, indicating that they believed it described one who was slightly better than average. On the other hand there was considerable agreement on the second item, "Is impatient while taking orders," all judges agreeing that it described an inferior waitress, with more than two-thirds of the judges assigning the item a value of 20.

TABLE 28.—EXAMPLES OF AMBIGUOUS AND UNAMBIGUOUS ITEMS ON RATING OF WAITRESSES AS DETERMINED BY THE FREQUENCY OF JUDGES USING EACH SCALE VALUE

Item	Scale value							Total number of judges
	10	20	30	40	50	60	70	
Fast but makes mistakes in orders..................	3	3	10	7	2			25
Is impatient while taking orders..................	1	18	6					25

7. As a final step, items are selected that represent all levels of ability on the scale on which the items were evaluated, and at the same time cover all aspects of the job as indicated by the job analysis. Depending upon the total number of items desired in the scale, one or more items are selected to represent proficiency at the levels indicated by values of approximately 10, 15, 20, and so on to 70.

In using a check list of scaled items the supervisor simply checks those items on the form he feels describe the particular worker being evaluated. No restrictions are put on the supervisor as to the number of items he needs to check. However, experience indicates that a satisfactory number ordinarily is checked. The worker's final rating is taken as the average of the scale values of all items that his supervisor has checked in describing him.

Some Results Employing Check Lists.—Although no studies have been made concerning the extent of constant and halo errors in this type of rating as compared with other rating forms, it would appear likely that this procedure would reduce these errors to a minimum, in view of the specific nature of the behavior described in the items. Insofar as reliability is concerned, striking results have been reported by Richardson and Kuder.[22] For 330 salesmen rated twice by the same raters on a 36-item form, a period of 1 month elapsing between the two ratings, the coefficient of correlation between the two sets of ratings was found to be 0.85. The coefficient of correlation between ratings of 305 salesmen made by two independent raters was 0.83. Goertzel developed a rating form of scaled items for generalized use, attempting to provide a scale that could be used for assessment of workers on any type of job.[23] For various groups of workers Goertzel found a coefficient of correlation of approximately 0.80 between ratings on two forms of 25 items each.

THE NATURE OF THE TRAITS BEING RATED

It has been found by numerous investigators that certain traits are rated in a much more reliable fashion than are other traits. In Table 29 are shown the reliability coefficients of ratings of steel workers on 11 different traits.[24] It will be noted that there is considerable variation in the reliability with which the different traits are rated. The question naturally arises concerning the nature of the traits that are reliably judged as compared with those which are rated in an inconsistent manner. In the following discussion it will be shown that the traits most accurately judged are those for which there is objective evidence, those which are simple, and those which are carefully defined.

TABLE 29.—THE RELIABILITY COEFFICIENTS OF RATINGS OF 4,500 STEEL WORKERS ON 11 TRAITS

Trait	Reliability Coefficient
Safety	0.35
Health	0.36
Cooperation	0.37
Personality	0.39
Judgment	0.45
Accuracy	0.45
Productivity	0.46
Knowledge of the job	0.46
Versatility	0.47
Industriousness	0.47
Initiative	0.48

Objectivity of Traits.—It is generally believed that those traits which are of the so-called "objective" type are more reliably rated than those of a subjective nature. However, it is not an easy matter to differentiate traits in terms of objectivity. What is it about a trait that makes one trait objective and another subjective? Furthermore, examination of the evidence indicates that, in many cases, traits that are generally considered to be more objective than others actually are less reliably judged. Thus punctuality would be considered by most persons to be more objective than cooperativeness; yet Slawson found the reliability of punctuality to be only 0.41 while that of cooperativeness was 0.52.[25] On the basis of results thus far obtained the best conclusion that can be drawn appears to be that of Symonds, viz., that the traits that are most reliably judged are those which leave their mark on things or influence external events.[26] In other words, traits for which there is external and objective evidence are the ones that are most accurately judged.

Simplicity of Traits.—It has been pointed out that, insofar as possible, ratings should be made of simple traits rather than of more general traits or of traits that are a composite of a number of simple traits.[27] If workers are rated on the more general traits, there is greater possibility of error, since some raters will base their judgments on certain aspects of performance included under the general trait name, whereas other raters will base their judgments on other aspects. Furfey found that the reliability of ratings on a given trait is increased if that trait is analyzed and subdivided into its parts, and if ratings are obtained on each of the parts rather than on the single more general trait.[28]

Degree of Definition of Traits.—The less well defined a trait is the more opportunity will there be for error, since different raters will interpret the meaning of the trait differently. Consequently each trait that is to be rated should be carefully defined with all its aspects specifically described.[29] Such definition and specification will tend to focus the attention of all raters on the same areas of behavior for all individuals being rated.

THE CHARACTERISTICS OF RATERS

Guilford has made a careful review of the literature concerning the characteristics of individuals who are good raters.[30] Insofar as the industrial situation is concerned, a good rater is one who (1) is interested in the ratings that he makes, (2) takes his time in making his ratings, (3) is well adjusted personally, (4) is sympathetic and understanding of people, (5) is not necessarily self-consistent, (6) is well aware of his own capabilities and limitations, and (7) is trained so that he understands the operation of, and compensates for, the errors that may affect accuracy of rating.

As Guilford has pointed out, it cannot be said that there is a "general judicial capacity." An individual may be a good rater for certain traits or for certain groups of workers and not for other traits or for other groups of workers.

THE SITUATION IN WHICH THE RATINGS ARE MADE

The particular rating technique employed is a less important factor in the accuracy of ratings than is the caliber of the rater employed, and each in turn is far less important than the situation in which the ratings are made. The best possible physical form of a rating scale can be used by the most competent raters, and the final ratings still may be completely undependable if the rating situation is not adequate. Experience has shown that at least six different factors in the rating situation are important in relation to the accuracy of ratings.

Extent of the Rater's Knowledge of the Behavior and Characteristics of the Persons Being Rated.—It is obvious that the more familiar the rater is with the behavior and characteristics of the person to be rated, whether through greater opportunity for observation or longer time of observation, the more accurate will be the ratings. Just what constitutes adequate familiarity will have to be determined for every job. Perhaps for certain simple routine jobs, one or two months will suffice, but for more complex and varied jobs a period of years may be necessary. It is important to remember that, even though an individual acts as the supervisor of a group of workers, it does not necessarily follow that he is sufficiently familiar with them to make accurate ratings. In many instances the supervisor has many operational functions of his own and only incidentally performs personnel duties and evaluative functions. Similarly the length of time an individual supervises a group of workers may not be indicative of the extent to which he is familiar with their performance. Long-time casual observation is less effective than short-time intensive observation.

The Amount of Time Available to the Rater for Making the Ratings. In order to accomplish accurate ratings the supervisor must have time to collect, systematize, and analyze all the impressions and opinions he has about each of his workers. The less time he has to organize his thoughts and materials, the less accurate will be his ratings. This factor is pertinent since, as has already been mentioned, supervisors usually have certain operational duties that must be accomplished, and ratings ordinarily are an additional task fitted in as time permits—and usually there is very little time. In addition, many organizations call for reports of ratings on very short notice. In either situation the supervisor can make but perfunctory ratings that will be highly inaccurate. A supervisor should be allowed a minimum of from 15 min. to ½ hr. free time for the rating of each individual.

The Social Relations between the Supervisors and the Workers.—It has been reported that raters assign higher ratings to their colleagues and fellows than they do to other persons.[31] This means that an individual cannot be expected to rate in an accurate fashion any close friends who are working under his supervision. In those situations where the supervisors and the workers form a tightly knit social group, the ratings by the supervisor probably will not be satisfactory.

The Extent to Which the Supervisor Must Justify His Ratings to His Superiors.—Under certain circumstances the rater may be called upon to justify before his superiors the ratings he has assigned to one or more persons working under him. Usually it will be in those cases where he has assigned either very high or very low ratings that justification will be required. A supervisor of strong and honest convictions will not have any great trouble in this respect, provided he feels that he made the ratings under proper and favorable circumstances. A supervisor with less strength of character, or one who is not satisfied that he can do a good job, will attempt to assign ratings that will not require justification. In general such ratings will be "average" or slightly above average ratings. By this means the supervisor plays safe and avoids being caught.

The Extent to Which the Supervisor Must Justify His Ratings to the Workers He Rates.—As in the above situation, a rater must have considerable strength of character and be satisfied with the adequacy of his ratings before he will make accurate ratings, knowing that his ratings are open to the workers for inspection. In many organizations the ratings are open to the inspection of the workers, and they are free to challenge the ratings. Under these circumstances the supervisor will feel in general that it is easier to assign high ratings to all workers than face the ire of those who might receive low ratings.

The Use of Ratings for Purposes Other than Evaluation.—Supervisors often use ratings of their workers as motivational devices. If it is felt that a particular worker needs bucking up, depending upon the personality of the worker, a supervisor might rate him either lower or higher than his true performance merits. In effect the supervisor is using reproof and praise in an attempt to motivate the worker to higher levels of performance. Obviously, if ratings are used for such a purpose, they are useless for evaluation. In other cases a supervisor will rate an individual higher than he ordinarily would if he feels that it will help the individual obtain a promotion or raise. This again makes the rating an inadequate estimate of the worker's ability or effectiveness.

The Responsibility of Management in Rating Programs.—Knowing that the accuracy of ratings is very closely dependent upon these six factors of the rating situation, it is the obligation of management, in a given evaluative program requiring ratings, to see to it that each factor operates as favorably as possible. To some extent this can be done by setting up sound general policies in regard to purposes and uses of proficiency measurements of the workers. A further important step, in order to gain optimum conditions for accurate measurement, is to provide a very thorough training in rating methods for all supervisory personnel.

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CHAPTER V

THE INTERVIEW AND PERSONAL-DATA ANALYSIS

In personnel practices the interview is the principal instrument used to obtain information about individuals. Private business and industrial organizations seldom hire an applicant for any position unless he is interviewed by some representative of management. The interview may be long and involved, consisting of several sessions between the applicant and one or more interviewers, or it may be a more or less perfunctory affair lasting 5 or 10 min. A very intense faith is placed by personnel officers in this method of assessing applicants. Although other selective procedures may be judged critically and rejected, one seldom finds the interview rejected, even after being carefully evaluated and found deficient. The general feeling seems to be that, even if the "figures" do not offer positive proof of the effectiveness of the interview in the selection of workers, the method is nevertheless of some value.

We shall see from the following discussion of the interview method that to a considerable extent we are still in the stage of formulating the basic problems. As a consequence the number of pertinent scientific studies of effective interview procedures and allied problems is small. Indeed the number of investigations relative to the basic problem of the validity of the interview probably would not be considered sufficient to arrive at any final judgment of the adequacy of any other selective method. As a primary method for use in the selection of employees, therefore, the interview cannot simply be accepted as a tried and true procedure. Nevertheless many organizations that have refused to accept some other carefully evaluated selective procedure because the validity of the method was considered insufficiently high have continued to use the interview without any attempt whatsoever to evaluate its effectiveness. The effectiveness generally is accepted on purely a priori grounds. Although such faith may be deserving, it will be well to ascertain whether it is justified.

THE INTERVIEW IN RELATION TO RATINGS

As a means for the evaluation of individuals, the interview is intimately related to ratings. In both procedures facts concerning the individual are used by some other person in ascertaining fitness for a job. The assessment in both cases is based upon opinion and judgment. The difference between the two methods is that ratings are used to classify individuals known to the judge, whereas the employment interview is used primarily for classifying persons previously unknown to the judge. To be sure, the interviewer in evaluating an applicant may record his judgment in the form of a rating, perhaps even utilizing a systematically developed rating scale or series of scales. The major difference, however, is found in the degree to which the judge—the rater in the one case and the interviewer in the other—knows the individual under consideration.

Since ratings and the interview are so closely allied, it is obvious that to a considerable extent generalizations and principles developed in connection with the former will hold true for the latter. The types of errors made by raters are likely to be made by interviewers. Techniques found to improve ratings probably will improve the interview. Knowledge of problems and methods in the area of ratings, therefore, will constitute an important basis for understanding the interview.

RESULTS OBTAINED WITH THE INTERVIEW

The Unsystematic Interview.—The casual and haphazard manner in which interviews are commonly conducted certainly does not justify their widespread use. As a rule the individual chosen as an employment interviewer is simply one who has risen in the ranks of the personnel department. Although such a person is likely to be highly motivated toward his work and interested in people, there is too often little in his background or training to justify his placement. Furthermore, beyond the setting down of rather general areas to be explored by the appraiser, there is little or nothing done by way of planning the interview. The interview is conducted as a spur of the moment inspirational affair. All such haphazard attempts are lumped together under the term *unsystematic interview.*

Studies of the unsystematic interview generally have shown that its dependability is likely to be little better than chance. In a study now classical, Hollingworth compared the rankings made by 12 sales managers of 57 applicants interviewed by them.[1] The rankings of 4 of the applicants by the 12 interviewers, presented in Table 30, illustrates almost complete lack of agreement among the sales managers. For example, applicant I was judged by sales manager K as being the best applicant in the group, and by sales manager I as being the poorest. Other discrepancies may be seen in the rankings assigned to the other cases. Kornhauser had a group of judges repeat their interviews with the same group of individuals and found correlations between the two sets of interview ratings for the least consistent judge to be 0.42, and for the most consistent judge, 0.78.[2] These coefficients of correlation probably are too high for a true index of reliability, since the judges were certainly influenced in the second interviews by the opinions they had formed in the first ones.

TABLE 30.—RANKINGS OF 4 OUT OF 57 APPLICANTS BY EACH OF 12 SALES MANAGERS

Applicants	Sales managers											
	A	B	C	D	E	F	G	H	I	J	K	L
I	53	10	6	21	16	9	20	2	57	28	1	26
II	33	46	6	56	26	32	12	38	23	22	22	9
III	54	41	33	19	28	48	8	10	56	8	19	26
IV	43	11	13	11	37	40	36	46	25	15	29	1

The results of these studies have been confirmed by several other investigations. The general indication is that the employment interview of the unsystematic sort, as it is usually conducted by personnel officers, has a reliability far lower than that which they generally attribute to it. Since the validity of a technique is limited by its reliability, and usually is lower, it may be said that these unsystematic interviews have low validity.

The Systematic Interview.—It should not be concluded from the foregoing discussion that the employment interview is unacceptable as a method for selecting employees. It should be concluded that, placed in the hands of inadequately trained and inexperienced persons and without proper procedural refinements, the method does not differentiate with sufficient accuracy individuals with high potential from those with low potential. It must be remembered that the interviewer is doing a professional job and consequently should have the qualifications of a professional person. Furthermore a systematic analysis of any problem can be expected to yield far better results than any haphazard casual procedure. It is not surprising, therefore, to find that in many instances the systematic interview does give quite adequate results. Thus Hovland and Wonderlic found that, when placed on a professional plane, the interview gave reasonably good reliability and validity.[3] Newman, Bobbitt, and Cameron report correlations ranging from 0.80

to 0.89 between the ratings of pairs of interviewers.[4] Other results obtained with the systematic interview also bear out its value.

SOURCES OF ERROR IN THE INTERVIEW

In systematically analyzing any method for assessing individuals the first step is to consider the sources of error that might operate to reduce its dependability. Knowing something about the factors that reduce dependability permits steps to be taken to eliminate or minimize the effects of such factors. As far as the employment interview is concerned, there are three principal sources of error, viz., the applicant, the interviewer, and the interview procedure itself.

The behavior of an individual is not constant from day to day or even from hour to hour. Change in an individual's mood is reflected in his behavior, and variation in environmental conditions produces marked differences in his ability to perform. The individual applicant is therefore not a constant reactor but rather is varying somewhat all the time. The interview situation may produce variations that will result in a nonrepresentative performance and in inaccurate assessment of the interviewee's abilities, interests, and personality traits. Furthermore, error may arise through faulty or inaccurate information given by the applicant. The interviewer too is a variable in the situation. One interviewer may see certain qualities in an applicant not seen by another. An incomplete picture of the interviewee might be obtained if he is seen by only one person. Thus the interviewer, as a variable factor, may distort the assessment. Finally one type of interview procedure may yield more complete and accurate information than another procedure, and so the procedure employed is an important consideration. In the following sections we shall consider the applicant, the interviewer, and the interview procedure in order to gain some notion of the problems involved in interviewing, and the ways in which errors can be eliminated or reduced.

THE APPLICANT

Making More than One Interview.—It has been noted that different interviewers show far from perfect agreement among themselves concerning the potential for a particular job displayed by the same applicant. That all the variation between the judgments of the interviewers is not wholly due to a lack of consistency among them is indicated by a study by Kornhauser.[5] This investigator found that discrepancies between the ratings made by different interviewers can be attributed in part to the differences in behavior or attitudes at different times on the part of the person being interviewed. The applicant himself is variable. Thus the conclusion may be drawn that the interview can be improved if each applicant is interviewed more than once. This conclusion is supported by the fact that closer acquaintance with the individual being interviewed results in increased reliability of interviewers' estimates.[6]

Obtaining Information from Sources Other than the Applicant.—A fact that interviewers frequently forget is that information about an applicant can be obtained from sources other than the applicant himself and by methods other than the interview. In many cases, even though the applicant is willing and eager to give information, he may be unable, in the verbal report he makes of himself in the interview, to furnish evidence of certain of his qualifications. As a simple example, arithmetic ability is better appraised by a test than by the applicant's memory of how he did in the subject in school. As we shall see in subsequent chapters, tests can give a variety of different types of information in a highly accurate manner and certainly much more adequately than can be obtained by means of an interview. Similarly information concerning an applicant's school grades can be most accurately determined from a school transcript. It is difficult, particularly when applying for a job, for the interviewee to avoid a certain amount of memory stretching. There is little point in trying to evaluate the capabilities of an individual by means of the interview when that person is unable to present satisfactory evidence of his capabilities or is unable to demonstrate them.

Adequate Motivation of the Applicant.—The point of view generally taken is that if an individual is not sufficiently motivated to make a good case for himself in an interview, and as a consequence receives a low rating from the interviewer, he is not a desirable employee anyway, regardless of his qualifications. Such a point of view is only justifiable if it can be proved that such motivation is related to proficiency on the job. Although it has not been demonstrated that motivation in the interview is unrelated to job success, neither has it been demonstrated to be positively related to success.

Inadequate motivation in the interview may be due to a variety of factors, factors that actually may be unimportant as far as evaluation of the individual is concerned. Thus an individual who is already employed and has a satisfactory job may simply "shop around" a bit. By not developing high motivation in an applicant of this sort, the interviewer may be overlooking a good prospect for employment. It should therefore be a primary function of the interviewer to motivate the applicant to give as much information about himself as he can and to put forward the best case for himself that he is able to present.

THE INTERVIEWER

Individual Differences among Interviewers.—That interviewers differ among themselves in terms of reliability and validity of their interview ratings has long been known.[7] It has been found that the estimates of some interviewers agree quite closely with those of some others, while being in complete disagreement with those of still other interviewers. Similarly interviewers vary considerably in the validity of their estimates, some of the interviewers being significantly better than others in predicting whether or not an applicant will be a successful employee.

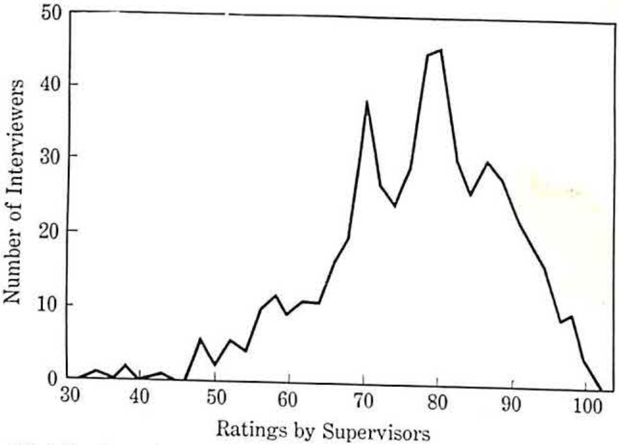

FIG. 15.—Distribution of supervisors' ratings of 522 employment interviewers.

The general notion appears to be that, although such differences exist among interviewers, they are relatively insignificant, but this view needs further examination. The extent of differences among employment interviewers may be gauged by a distribution of ratings made by supervisors of interviewers in the U.S. Employment Service.[8] The distribution of these ratings is shown in Fig. 15. In spite of the fact that these interviewers can be considered to be a fairly homogeneous group since they had all passed an appropriate employment examination, there is still considerable variation among them in terms of their proficiency in the interviewing situation.

Selection of Interviewers.—Since it is known that people vary markedly in their ability as employment interviewers, it is apparent that the interview could be made a very much better instrument if the interviewers were carefully selected on the basis of their ability to predict the future success of applicants. At present there are no tests or other standard devices by means of which good interviewers can be differentiated from poor ones. In the selection of their interviewers, employment offices for the most part will have to depend upon the interviewer's training and past experience in the field, realizing that judgments based on such information simply constitute good guesses at best.

Preselection, however, is not the only attack on the problem. Procedures should be established to check on the accuracy of each interviewer's predictions. Those interviewers who are ineffective should be transferred to other jobs or should be given specialized training for their work. Obviously there is little point in retaining an individual as an interviewer if he is unable to judge with any degree of accuracy which applicants will be successful and which unsuccessful.

Training and Experience.—Results obtained by Spielman and Burt indicate that with increasing practice in interviewing the reliability of interviewers' estimates increases.[9] O'Rourke also has noted an increase in the consistency of the judgments of interviewers after training.[10] Thus the training of interviewers in the problems and techniques of the interview results in an increase in the dependability of the method. Since experience more or less amounts to informal training, experience—guided experience particularly—should prove valuable.

Using More than One Interviewer.—The fact that the correlation between the estimates of two judges is not perfect may indicate the operation of factors other than the unreliability of their judgments. In many cases two different interviewers will note different aspects and qualifications in the same applicant. The pooled estimates of the two interviewers therefore will be superior to the estimates of either one because a more complete picture of the applicant is obtained. Although each interviewer's estimates may be valid as far as they go, the number of important qualifications he assesses will be incomplete. If the applicant is checked by a second interviewer, additional qualifications may be assessed. Therefore if the applicant is evaluated by more than one interviewer the accuracy of the evaluation is likely to be greater.

THE INTERVIEW PROCEDURE

Defining the Purpose of the Interview.—The primary purpose of the employment interview is to obtain pertinent facts about the applicant's experience and qualifications as a basis for determining his suitability for a particular job. Of course in addition it serves to give the applicant some notion of the position he is to fill, its nature, its advantages and disadvantages, and its future possibilities. Furthermore in many cases it is used as a means for developing public good will by establishing a friendly relationship between the organization and the individual, regardless of whether or not he is hired. From the point of view of the interview as a selective device, the important consideration is that it is a means of obtaining information about a person in order that an accurate evaluation may be made of his potentialities.

Securing Adequate Knowledge of Job Requirements.—As with other aspects of the employment problem, knowledge of the job and worker specifications is essential for accurate interviewing. The interviewer should have at hand specific and detailed information concerning the nature of the work the individual will have to perform, and the qualifications necessary in order to satisfactorily perform the work. Without such job information the interviewer will be unable to plan the interview so that all important areas are explored and assessed, and the appraisals combined in an optimal fashion to effect a final rating of the applicant.

Planning the Areas to Be Explored.—Having secured adequate knowledge of the job from the specifications, the interviewer is in a better position to systematically plan the course of the interview. He can outline with some degree of certainty the important areas that are to be explored and arrive at some conclusions concerning the types of questions most likely to be diagnostic of later success on the job. The more comprehensive the analysis that goes into planning the course of the interview, the better the results are likely to be. The importance of systematic interviews of this kind has been stressed by Bingham and Moore.[11] The value of the systematic interview lies in the fact that it provides the interviewer with certain guides relative to the kind of information he should be seeking from the applicant and permits him to integrate that information in a more meaningful manner in arriving at a final appraisal. Furthermore the systematic interview situation gives the interviewer a constant background against which the qualifications of the applicants can be more accurately judged.

The argument is often advanced that the use of such aids will eliminate informal discussion on the part of the applicant, and thus important information will not be revealed. Bingham and Moore, however, report that the use of such aids does not hamper but rather stimulates free and spontaneous discussion. This would seem likely since both parties will have a clear understanding of just what constitutes the subject of discussion.

It is necessary to understand that there is a difference between a systematic interview and a standardized interview. In the latter, specific questions are set for the interviewer and he asks them of all applicants in exactly the same manner. The effect is that the interview achieves little more than could be obtained by means of a printed questionnaire filled out by the applicant. In the systematic interview, however, the number of questions exactly set will be few, if any. Rather, it is the general type of questions that are given by the systematic interview procedure, the specific questions to be asked being the responsibility of the interviewer and developing out of the interview situation. The skill of the interviewer therefore, is of great importance in the systematic interview and is of little importance in the standardized interview.

The value of the systematic interview has been demonstrated by Hovland and Wonderlic.[12] These investigators prepared an interview blank consisting of topics dealing with the applicant's work history, family history, social history, and personal history. At the end of each of these four sets of questions asked of the applicant are questions the interviewer asks himself concerning the applicant's qualifications. Answers to the latter questions are scored plus or minus. The following is an example: "Has the applicant indicated ability to work consistently? (+) yes/no (−)." The pluses and minuses are counted for a given applicant, and from them a total score is obtained. A large number of pluses is taken to indicate that the applicant is promising, and a large number of minuses that he is not. Thus the applicant's answers to a systematically determined set of questions form the basis for the ratings of his qualifications made by the interviewer on another set of questions.

TABLE 31.—THE RELATIONSHIP BETWEEN SCORES YIELDED BY A SYSTEMATIC INTERVIEW FORM AND JOB SUCCESS

Job success	Interview score				
	0–10	12–16	18–22	24–28	30–34
On the job, per cent	39	43	47	49	59
Resigned, per cent	22	26	29	29	29
Dismissed, per cent	39	31	24	22	6

Hovland and Wonderlic report the reliability coefficient of their systematic interview to be 0.71 when computed as the correlation between the ratings of two interviewers. In addition they present evidence that justifies the assumption that the ratings of interviewers are diagnostic of future success. Table 31 shows the relationship between scores on the interview—number of pluses minus the number of minuses—and success on the job. It will be observed from this table that, as the interview score increases, the proportion of successful individuals on the job increases, and the proportion of dismissed individuals markedly decreases.

Securing Information Before the Interview.—It follows from the proposition that employment interviewing is a highly specialized type of activity that that part of the work which can be performed by less specialized personnel or accomplished by other means should not be done by the interviewer. In most instances much information concerning the applicant can be obtained before he enters the interviewing situation. If the interviewer has at hand all such pertinent information before he sees the applicant, he will be in a position not only to save time but also to plan more exactly the areas he feels need special attention for the particular applicant, and thus he may be able to specify his questions to a considerable extent. Before the interviewer begins his conversations with the applicant, therefore, it is desirable that he have some knowledge of the qualifications and capabilities of the individual he is to appraise.

Questioning Procedure.—Although there have been a number of experimental investigations concerning the effects of various types of question forms upon the interviewee's answers, such investigations have failed to provide the employment interviewer with a series of principles to follow in the questioning. Questioning is still an art. For the most part the interviewer will have to depend upon systematic analyses of a more or less logical sort in order to prepare himself along these lines.[13] The extent of differences among interviewers in questioning procedures has been found to be great. Uhrbrock noted the number of words spoken by the interviewer and by the applicant in typical employment interviews.[14] He found that on the average the interviewers did 60 per cent of the talking, ranging from one who did only 47 per cent to one who did 73 per cent of the talking.

One proposition that can be considered is the necessity of securing from the applicant the answer he actually means to give. As we have seen in connection with ratings, the same words may have different meanings for different individuals. It is essential that the interviewer verify the answers the applicant gives him. The full meaning of each statement that the applicant makes should be secured, and any doubtful statement should be reinterpreted or the question repeated in different terms, in order that complete agreement can be reached between the applicant and the interviewer.

THE EVALUATION OF INTERVIEW DATA

There are two opposing points of view in regard to the manner in which the information obtained in an interview should be evaluated in arriving at a final assessment of the applicant.[15] On the one hand there is the point of view holding that the job should be broken down into its various specific aspects, and the applicant evaluated in terms of his qualifications in each of these. The final appraisal should be the total or average of the ratings on all the specific qualifications. The second point of view holds that such a breakdown is useful only in terms of the aid it gives the interviewer in covering all important areas. The final assessment, however, should not be based directly upon the ratings in each of the specific aspects of the job but should take into account the picture of the applicant as a whole. The former is an atomistic approach to the appraisal of the individual, and the latter is a holistic approach.[16]

It is difficult to evaluate these two approaches. Certainly in terms of the evidence available at the present time it cannot be said with any high degree of certainty that one is superior to the other. The atomistic point of view would seem to be advantageous in that it permits evaluation of specific phases of the applicant's qualifications that may be useful in further studies. When the interviewers' ratings of particular qualifications are compared with measures of job proficiency obtained at a later time, it is ordinarily found that certain of the ratings are distinctly more valid than others. In Table 32 are given the validity coefficients of interviewers' ratings of applicants for positions in social service work. It will be observed that in only one case are the ratings on specific qualifications lower in validity than the over-all assessment of the applicant's qualifications. Obviously, the total or average of the ratings on specific qualifications should have higher validity than the final over-all assessment. Either by giving

TABLE 32.—COEFFICIENTS OF CORRELATION BETWEEN INTERVIEWERS' EVALUATIONS OF APPLICANTS FOR SOCIAL SERVICE WORK IN RELATION TO LATER OBTAINED MEASURES OF JOB SUCCESS

Qualification	Validity Coefficient
Appearance, poise, and manner	0.26
Comprehension	0.39
Address and speech	0.18
Education	0.19
Training and experience	0.19
Over-all fitness	0.19

greater weight to those qualifications found to be more predictive of later success or by recasting the evaluating procedures for the less validly rated qualifications, the total validity of the interview could be improved.

The counter argument to the atomistic approach is that it analyzes the individual in a highly artificial manner likely to bear little or no resemblance to the total integrated person. The atomistic approach does not allow the interviewer to take into consideration any compensatory effects that he might discover. For example, an applicant might not have quite the work history and past experience deemed necessary for a given job, but the interviewer, working on the basis of the holistic point of view, might hold that these differences are unimportant since the individual is highly motivated and has exceptionally good work habits.

On the basis of the holistic approach to the assessment of applicants one would expect to find that the validity coefficients for ratings on specific job qualifications would have low or negligible validity in the prediction of later success, and that the validity of the over-all assessment would be high. In Table 33 are presented data relative to the validities of certain qualifications of men in terms of their potentiality as executives, as evaluated by interviewers. It will be observed that, for the most part, the validity coefficients of the ratings on specific qualifications are not greatly different from zero, but that the validity of the over-all assessment is quite high. These results are directly opposite to those supplied in Table 32 and discussed above.

TABLE 33.—COEFFICIENTS OF CORRELATION BETWEEN INTERVIEWERS' EVALUATIONS OF POTENTIAL EXECUTIVES IN RELATION TO LATER OBTAINED MEASURES OF JOB SUCCESS

Qualification	Validity Coefficient
Educational background	0.24
Occupational experience	−0.10
Interest	0.29
General intellectual ability	0.00
Sociability	0.34
Emotional stability	−0.16
Initiative and drive	0.08
Self-confidence	−0.16
Over-all fitness	0.71

How can the discrepancy between these two sets of results be reconciled? The probable answer can be found when the difference between the two sets of interviewers is taken into consideration. The individuals who interviewed the applicants for social service work were either persons experienced and advanced in social service work or persons who held administrative positions. On the other hand the interviewers who assessed the potential executives were highly trained professional psychologists, with long experience in the appraisal and analysis of human capacities and traits. The accuracy of the over-all assessments of the first group of interviewers, those without specific training and experience in interviewing, was inadequate, although they were able to rate certain specific qualifications with somewhat greater accuracy. The experienced interviewers, although not attempting to arrive at accurate estimates of specific qualifications, did provide an over-all estimate of rather high validity. Therefore it would seem that, when the interviewers do not have a specific background and training in techniques of psychological appraisal, it is better to have them evaluate applicants in terms of specific qualifications, and take as the over-all rating the total or average of the ratings on specific qualifications. For experienced interviewers, however, it is likely that the final over-all appraisal will have greater validity than the total or average of interview ratings on specific qualifications, since the skill of the interviewer will permit him to take into consideration the particular configuration of qualifications in each applicant.

PERSONAL-DATA ANALYSIS

Present Use of the Application Blank.—Almost invariably in the employment process the applicant is called upon to report certain personal data. In addition to identifying information such as name and address, the application blank often calls for educational and occupational history, marital status, and similar items. The evaluation of personal data as given on the application blank has been subject to even less critical examination than the interview. In a survey made by the authors it was found that none of the personnel officers contacted was willing to admit that his application blanks were not revealing of later job success, even though there was almost a complete absence of supporting evidence. In reporting on the manner in which they used the application blank as an aid in the selection of new employees, a large proportion of the personnel officers reported that they based their judgments primarily on the answers to a few "particularly revealing" items.

Assumptions in the Use of the Application Blank.—The use in this manner of responses to personal-data items in the application blank presupposes that the questions contained in it are diagnostic of success on the job, and that the information given by the applicant is accurate. Such evidence as is available indicates that neither of these assumptions can necessarily be granted. If the predictions are valid, it follows that the questions yield information concerning aptitude for the job. This, however, does not appear to be the rule. In one survey of the content of application blanks, for example, it was found that the larger part had nothing to do with the particular job in question.[17] Indeed a number of investigations have found that, for most of the items on the blanks, there is little or no correlation between the answers and the criteria of later job success. Only about one out of five or ten items may be expected to show a forecasting efficiency better than chance, and without pretesting the questions it would be next to impossible to differentiate the good items from the poor ones.

It is to be expected that the information given by the applicant will not necessarily be accurate. Apart from deliberate falsification, the applicant may misinterpret the questions, not be qualified to answer some of them, and even forget or overlook certain important information. In the Army during the First World War, it was found that, of those individuals who claimed to be skilled in a particular job, only 6 per cent really had adequate skill, and 30 per cent were actually totally inexperienced.[18] In applications for a position in a city department in New York, 2 per cent were found to have criminal records, although all applicants had sworn they had none.

Systematically Constructed Application Blanks.—These inadequacies on the part of application blanks should not be interpreted to mean that the method is completely inadequate and therefore should be discarded. Rather in any given case a systematic study should be made to discover empirically from answers given by applicants to the questions whether the answers are accurate or not, and which items show a correlation with success on the job. Results obtained by Cawl, which are given in Table 34, may be used as an illustration.[19] The criterion of success was ability to continue on the job, and the responses of the applicants were correlated with it. In the case of the clerical workers, only two of the ten items show any adequate correlation with success; in the case of the salesmen, six; and in the case of the accountants, two. These questions are the critical ones, and the remaining ones should be discarded. It is perhaps worth while to note that an item which gives predictive results for one job does not necessarily do so for another.

The fact that, of the items differentiating the better from the poorer prospects, some items give a better prediction than others has led to the

TABLE 34.—COEFFICIENTS OF CORRELATION BETWEEN ANSWERS ON AN APPLICATION BLANK AND LENGTH OF TIME ON THE JOB

	Clerks	Salesmen	Accountants
Number of cases	195	111	200
Length of time on last job	0.22	0.36	0.07
Length of time on next to last job	0.05	0.37	0.19
Average time on last three jobs	0.18	0.46	0.27
Average salary on last three jobs	−0.03	−0.13	0.07
Number of jobs previously held	−0.17	−0.22	0.03
Age at time of application	0.26	0.31	0.27
Height	0.07	0.02	0.05
Weight	0.10	−0.07	0.17
Number of dependents	0.00	0.20	0.00
Amount of education	−0.04	−0.02	−0.05

weighting of the responses. The simplest procedure for obtaining weights is the so-called "horizontal per cent technique."[20] In this method persons on the job are divided into two extreme groups on the basis of some criterion measure—upper and lower thirds, or halves. For each item the proportion of successful persons giving a certain answer is calculated and taken as the weight for that particular item.

Data taken from a study by Diehl and Paterson may be used to illustrate the manner in which weights are obtained.[21] The findings given in Table 35 are for a question concerning the type of job the applicant held before seeking to join the police service. Policemen on the job were rated superior, average, or inferior. The figures in the first two columns of the table are the percentages of the two extreme groups reporting the different kinds of previous jobs. The figures in the third column are the totals of the superior and inferior groups, and those in the fourth column are the percentage of those responding in each of the four ways who turned out to be superior officers. The figures in the fourth column may be interpreted as the chances of

TABLE 35.—CALCULATIONS FOR OBTAINING THE WEIGHTS FOR THE RESPONSES TO A QUESTION RELATIVE TO TYPE OF JOB PREVIOUSLY HELD

Previous job	Superior officers, per cent	Inferior officers, per cent	Total	Successful, per cent	Simplified weight
Clerical and minor executive	9	21	30	30	−2
Skilled trades	8	7	15	53	0
Semiskilled	20	25	45	44	−1
Unskilled	63	47	110	57	+1

success of an applicant responding in a given way. For example, only nine out of thirty applicants, or 30 per cent, who had held a clerical or minor executive position turned out to be successful police officers.

The numbers in the fourth column could be used as weights to the answers, but for practical purposes the weights can be simplified. Since percentages less than fifty indicate failure, they may be assigned negative values. Setting 50 per cent as zero—equal chance of success or failure—60 per cent may be called +1, 70 per cent, +2, etc.; 40 per cent, −1, 30 per cent, −2, etc. These simplified weights are shown in the fifth column. Weights for the possible responses to every question are similarly computed by this method, and the responses to these questions scored in a corresponding manner. As a final check, the total score on the application blank is correlated with the criterion measure of proficiency.

The value of weighted personal-data items in application blanks has been demonstrated a number of times. Goldsmith was able to set a critical score on an application blank for life insurance salesmen so that 54 per cent of failures were eliminated and 85 per cent of successful salesmen were retained.[22] Manson found a coefficient of correlation of 0.40 between the weighted scores on an application blank and the production records of life insurance salesmen.[23] For the selection of paint salesmen, Ohman developed a blank whose weighted scores correlated 0.67 with earnings.[24] These investigations are only a sample of the many that have demonstrated the usefulness of the method.

It is impossible to list the application-blank items that will ensure good results, since, as has been pointed out, items valuable for selection purposes for one job may be wholly inadequate for another job. It is possible, however, to list characteristics that have been found useful as areas to be included in a *trial* application blank. For a particular job, of course, many of these will be eliminated. Items should be tried out on the following characteristics:

Age
Marital status
Number of children
Number of other dependents
Height
Weight
Years of education
School grades
Business college training
Number of jobs previously held
Average monthly earnings on jobs previously held
Average number of years on jobs previously held
Amount of life insurance
Amount of debts
Number of clubs
Types of jobs previously held
Reason for leaving last job

A new trend in personal history questions is to seek information concerning vocational and avocational interests, reading habits, etc.

The use of interest items such as these falls in the province of testing, a problem considered in the next few chapters.

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CHAPTER VI

USE AND CHARACTERISTICS OF PSYCHOLOGICAL TESTS

The need for correctly evaluating the abilities of men is as great in business and industry as in any field of human activity. An individual's realization of success in his work with its consequent personal happiness and satisfaction, together with the nature and amount of his contribution to the progress and profits of the organization for which he works, are directly conditioned upon matching the requirements of the work with the worker's abilities. To accomplish this there is need for developing measuring devices by means of which a correct assay can be made of the worker's aptitudes and proficiencies.

Psychological tests are one means available for evaluating ability. A test score provides an objective and quantitative description of an individual's capabilities. It is objective in the sense that the measurement is made of the actual performance of the testee; *i.e.*, the score on the test is based upon what the individual does or does not do in a given test situation. The score therefore is not dependent upon another person's judgment, as is the case if an interview or a rating is used in making the assessment. It is quantitative in the sense that the description is expressed in terms of amount. The ability being measured is considered to be a continuum; *i.e.*, to vary from no amount through increasing magnitudes to a very large amount. The score on the test is considered to reflect the relative amount of the ability possessed by the testee.

Psychological tests have made very significant contributions to the solution of problems of worker selection, placement, and adjustment. This is attested by the ever-increasing demand for tests being made by business and industry and by the growing number of fields of work for which tests are being devised. The outlook for the future is one of greater test development and application. The successful use of tests by various government services and private industries during the war years has added an immediate impetus to the testing movement. The consequent dislocations incident to reconversion, with labor shortages in some jobs and labor surpluses in others, will require the utilization of every device available that will assist in the matching of jobs and workers. Tests should therefore play an increasingly important role in vocational counseling and selection. It is therefore necessary to understand correctly the usefulness and limitations of measurements by means of tests. If tests are used unwisely, they can result in greater harm than if no tests at all are employed.

In the present chapter, consideration will be given to problems in which tests can be utilized, and to certain general characteristics of tests making for accurate and effective measurement. In the following chapter, principles of constructing and validating tests will be discussed.

CERTAIN APPLICATIONS OF TESTS

Selection.—The problem of selection is twofold: first, it is one of differentiating between applicants who possess the requisite qualifications for a job and those who do not possess the qualifications; and, secondly, it is the problem of grading or ranking the qualified applicants in order of ability from the highest to the lowest. In the first case the basis of selection is some minimum qualification, some test score that must be achieved or surpassed before the individual is considered satisfactory. In the second case, the basis of selection is the number of persons needed for the job. Thus if 20 persons are needed for a particular job and 50 applicants are tested, the 20 earning the highest scores are selected.

An example of the first type of selection is the situation that existed in most industries during the past war. Any person who had the minimum qualification score on the selection test usually was hired. Anyone who earned a score below the minimum, however, was considered too poor a risk to be tried out. The so-called "competitive" civil service examinations are an illustration of the second type of selection. In this case a certain number of vacancies for a particular position exist. On the basis of the test employed, the applicants for the position are ranked in order of their ability. Beginning with the highest ranking individual and proceeding down the list, that number of persons needed to fill the vacancies is selected. Test methods have proved an invaluable aid to personnel managers in selecting prospective employees because, if correctly constructed and administered, a test does allocate the testees along a quantitative scale of ability from the best to the worst.

In considering the use of tests in selection it is necessary to keep in mind the further problem of whether the measurement is to be restricted to the testee's ability to do the immediate job for which he is being considered, or whether future promise for higher jobs, together with present ability, is to be evaluated. Of the two, the measurement of potential growth and development presents the more difficult problems. The construction of adequate testing devices in this field is as important as the construction of tests for the entry jobs, especially since the general practice in selecting supervisors and minor executives and administrators is to choose them from those already employed. It is obvious that, if in the original selection of the workers no attention is paid to the evaluation of potentiality for higher jobs, there will be little assurance that sufficient numbers of qualified individuals will be available for such jobs. In some departments under civil service appointments this problem has been encountered. Owing to a popular sentiment against including in civil service examinations any tests not directly related with the specific jobs for which workers are needed, tests of potentiality have been omitted, and it has been difficult to get sufficient numbers of employees who have the potential ability to develop the qualifications required for the higher supervisory and executive positions.

Classification or Placement.—For many years business and industry have been giving considerable attention to fitting the man to his work, but they have not been giving sufficient attention to fitting the work to the man. In any large concern employing several hundred workers there will be many jobs requiring about the same level of general capacity but differing in respect to many specific requirements of the work. A new employee will therefore be a potential worker for any one of several jobs. The problem then arises of finding that particular job in which he will perform best, both in terms of production and personal satisfaction. There has always been a certain amount of transfer and adjustment of workers on the job, but little systematic effort has been made to develop techniques or procedures for use as aids in dealing with such problems. Tests should prove useful in such a program, both for establishing the minimal essentials for each, and for measuring the differences of workers in the specific qualifications in which the jobs themselves differ.

Whereas in selection the problem is one of accepting or rejecting individuals relative to a particular job, the situation is just the reverse in classification or placement. Here the problem is the selection or rejection of jobs relative to the individual. The task is to discover in which of several available jobs the individual is likely to achieve greatest success.

With the gradual substitution of machines for human labor and the consequent change in the type of work required of the employee, there is always a need for a continual worker adjustment within industry. It would appear that vocational counseling and adjustment within large firms will take on more importance in the future. It should not be expected that the initial selection of a job by a worker, or the initial selection of a worker for a given job, will prove satisfactory in all instances or even in a very large majority of instances over long periods of time. Consequent readjustment through change in classification should be the accepted policy, and tests should prove invaluable in effecting correct readjustments.

Training.—In recent years many business and industrial organizations have developed their own training schools as well as on-the-job training courses to supplement the experience of the worker and to teach him the details of methods and procedures peculiar to the organization and to his job. Refresher courses also are instituted when work methods are radically changed or when transfers and promotions are being planned. In every course of training, several needs are served by measuring instruments. Answers to the following questions are in part determinable by means of tests: Which workers need training? In what phases are they particularly deficient? How much training does each worker need? To what extent is the course of instruction actually getting over to the workers? At what point in training is each worker ready for actual placement on the job?

It will be noted that these questions are based on a clear recognition of the fact of individual differences. Workers differ markedly in their preparation for work, in their speed of learning the new requirements, and in their retention of what they learn. Training courses should therefore be based on the needs of the individual worker. In the long run the organization gets greater return from such individualized courses, because the worker is off the job a minimum amount of time and because he becomes a much better producer owing to having his individual problems solved. By means of tests it is possible to gain insight into the needs of the individual, to measure his progress throughout the training period, and to learn when he is capable of being placed on the job.

Promotion.—In many cases jobs are organized in a hierarchical arrangement, and those lower in the scale are considered necessary stepping stones to the attainment of those higher in the scale. Seniority in time on one job is frequently the sole condition for advancement to another job. In certain instances only a minimum of ability is required, and the experience gained on the lower job is sufficient preparation for the higher job. A combination of seniority with high ability for the new position would give a better basis for advancement. If preparation for the higher job is an important determiner, there will be an added incentive for becoming proficient in the knowledge and skills of the new job. Competition and rivalry, which will be reflected in greater improvement, will be engendered.

By means of tests it is possible to estimate the relative abilities and qualifications of all applicants for the higher job. Test scores used for this purpose are readily accepted by the majority of workers because such scores are objective and impartial. Promotions based on judgments and opinions of supervisors cannot avoid being biased by personal preferences. Favoritism is not conducive to high worker morale. Objective test scores coupled with factors of seniority and job experience ordinarily prove acceptable for the majority of employees as a basis upon which to determine promotion.

USE OF TEST SCORES IN PREDICTING CRITERION MEASURES

Tests as Predictors.—In an earlier chapter the nature and characteristics of criteria were discussed. It was pointed out that criteria serve as measures of the worker's success on the job. In the use of tests as bases for selection and placement, the test scores are used as predictors of these criteria. In selection the test score is obtained before hiring the worker. It serves as a short cut for getting information on the probable success of the worker without actually hiring him and requires little outlay of either time or expense. However, before test scores are used in this fashion they must be checked against some measure of job success. Criterion measures are therefore needed as a means for determining the predictive effectiveness of the test scores.

This process of determining the degree of effectiveness with which a test predicts success on the job is called "validation." A test that has been shown to predict a criterion is said to be a valid test. Some adequate measure of validity is absolutely necessary before the value of a test is known and before the scores on a test can be said to have any meaning as predictors of job success. Actually the significance and value of a test are unknown until the test has been checked against an adequate, independently determined criterion. Different tests will vary in terms of their degree of validity in predicting a particular criterion, and one and the same test will vary in terms of the validity with which it will predict different criteria.

Frequently one finds claims being made for tests that are not founded on empirical validation, and the test scores are interpreted with a certainty and finality not supported by the statistical facts. Occasionally a complete naïve faith is found which ascribes almost an attribute of magic to the test score. The use of unverified tests, whether through innocence or intent, cannot be condoned.

Referring Tests to Definite Criteria.—In the discussion of criteria of job success, it was made clear that there are many ways of evaluating a worker's proficiency on the job, and that there is seldom perfect agreement between two or more different measures of the same job performance. It follows, then, that a given test will not necessarily predict each of several criteria of a given job equally well. Suppose that success on a job is measured by output and wastage. Scores on a test might be found to be correlated with output but not with wastage, or with wastage but not with output. The reason for this is that output and wastage are neither perfectly related nor equally valid measures of job success. This means that a test can be a valid predictor of one criterion and not of another.

In Table 36 are shown the validity coefficients of several tests used in the prediction of success in various courses of training for aviation maintenance men.[1] It will be noted that the tests vary considerably in the accuracy with which they predict the different criteria. Thus the analogies test best predicts success in the course in electricity, whereas the mechanical-movements test best predicts success in blueprint reading and mechanical drafting. A test therefore can be considered valid only in reference to a given criterion. The statement one frequently hears that a particular test is a good test is meaningless unless the test is referred to a definite criterion. In other words a test

TABLE 36.—VALIDITY COEFFICIENTS OF SEVERAL TESTS FOR GRADES IN THREE BASIC COURSES FOR 105 AVIATION MAINTENANCE TRAINEES

Test	Courses of instruction		
	Shop mathematics	Electricity	Blueprint reading and mechanical drafting
Number series	0.37	0.15	0.24
Analogies	0.26	0.35	0.23
Addition	0.39	0.23	0.08
Mechanical movements	0.08	0.12	0.40
Surface development	0.35	0.21	0.50

is good or bad, *i.e.*, valid or not valid, *not* in general but only in regard to a given criterion.

Furthermore it should be pointed out that in practice a test is no better than the criterion against which it has been validated.[2] If the criterion itself is not valid, then a test predicting it is not useful, even though accurately measuring the criterion. If a test is known to measure some psychological ability, such as arithmetic ability, it still cannot be considered a valid predictor for any given job criterion until it has been checked against that criterion. Again, if the criterion does not adequately cover all the phases of job success, a test correlating with it can be considered to predict only those phases of the job measured by the criterion. This fact points up the need for making accurate and thorough job analyses in which not only all the phases of a job are discovered, but also the relative importance of the different phases is determined. With such information it is possible to assign weights to the different criteria or phases of a single criterion. It also enables the constructor of the test to represent all the measurable phases of the job in the test and assign accurate weights to the several parts of the test so constructed.

Reliability and Test Effectiveness.—In addition to the extent to which the criterion truly represents all aspects of the job, the reliability of the criterion also is an important consideration in the validation of tests. Even if the reliability of a test is very high, the scores it yields cannot be expected to show a very high correlation with some measure of job proficiency if that measure of proficiency itself is highly unreliable. For example, suppose that the proficiency of a group was measured by means of ratings made by the office manager and the chief clerk. If the ratings made by these two individuals showed no agreement whatsoever, then it should not be expected that a test of clerical ability would show any correlation with a criterion formed of these ratings. Therefore the extent to which the scores on a test can correlate with a particular criterion measure is limited both by the reliability of the test and by the reliability of that criterion measure.

The limiting effects of reliability upon validity are shown in Table 37. In this table it may be seen that, if the reliability of a test were 0.80 and the reliability of the criterion also were 0.80, the highest possible validity of the test would be 0.80. If the reliability of the criterion were 0.20, then the highest possible validity for the test would only be 0.40. Hence, if the reliability of either the test or the criterion is very low, it is impossible to produce a validity coefficient high enough for any practical use. It should be emphasized that the table does not show how high the validity coefficient will be when the reliability coefficients of both measures are known, but rather the limits above which it cannot go. Even if both measures were perfectly reliable, the validity coefficient might still be 0.00.

TABLE 37.—THE HIGHEST POSSIBLE VALIDITY COEFFICIENT A TEST CAN HAVE IN RELATION TO THE RELIABILITY OF THE TEST AND THE RELIABILITY OF THE CRITERION

Reliability of the criterion	Reliability of the test					
	0.00	0.20	0.40	0.60	0.80	1.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.00	0.20	0.28	0.35	0.40	0.45
0.40	0.00	0.28	0.40	0.49	0.57	0.63
0.60	0.00	0.35	0.49	0.60	0.69	0.77
0.80	0.00	0.40	0.57	0.69	0.80	0.89
1.00	0.00	0.45	0.63	0.77	0.89	1.00

NATURE OF THE TESTING SITUATION

It was pointed out in the last section that a test has meaning only in terms of its usefulness for prediction, and that its significance is made precise by validating the test scores against specific criteria. In order to realize fully the limitations of test methods and to learn the need for restricting the interpretation of the test scores to empirical facts, it is necessary to consider carefully the basic nature of tests.

Tests as Samples.—As indicated earlier, tests are short-cut methods for the prediction of job success. They are used as a substitute for actually placing an individual on the job and seeing how well he performs. Therefore, as with any short-cut method, a test does not measure in entirety the variable to be assessed but rather merely samples the variable. Information concerning the quality of cotton in a given bale is best obtained by studying every fiber in the entire bale. Since this is an impossible task, practically, a sample of the fibers is studied. Insofar as the assessment of human abilities is concerned, tests operate in exactly the same fashion. Samples of a variable must always be considered as what they really are, merely samples. Of necessity there will be errors, and it is important to understand the causes of such errors as they arise from the sampling situation.

Tests as Sample Stimuli.—First, a test situation is an artificially organized and controlled environmental stimulating situation devised for eliciting a given type of response from the testee, means being provided by which both the quality and quantity of the behavior can be recorded for later evaluation. A given test is a sample of many possible stimulating situations that might be used. It plays the role of an exciting cause to initiate behavior. It does not determine or cause the responses but merely acts to elicit them. The fundamental causes, or the factors determining the responses, are to be looked for in the native dispositions and past experiences of the individual. The test, however, narrows down the range of dispositions and experiences allowed to function. The word "ability" can be applied to any combination of related dispositions and experiences found to function together.

It should be apparent that the test as an exciting stimulus will not necessarily have the same exciting effect on every testee; *i.e.*, it will not be equally effective in getting all testees to respond in the same way. Whether the ability being measured is the same for every individual is dependent upon whether each stimulating item has the same meaning for every testee. Certainly, ambiguous items that can be interpreted in several ways cannot be considered constant stimuli. Regardless of how much ability is possessed by two individuals, a test may prove very effective with one and very ineffective with another in getting each to manifest his ability through response.

Tests as Samples of an Ability.—Secondly, the particular combination of native dispositions and past experiences called into play are determined primarily by the test. Whether the ability or abilities represented in the responses to the test are the ones desired can be determined through validation studies and should not be accepted on a priori grounds. Again the responses to the test are to be considered merely as one sample of the many ways in which the ability can be manifested. They become an accurate sample to the degree that they represent in quality and quantity the type of manifestation later to be found on the job.

Tests as Samples of Testee's Ability.—Thirdly, the responses to a test made by a testee on a given occasion are to be considered only one sampling of his ability. An individual given the same test on two occasions will not make exactly the same score, and sometimes the discrepancy between the two scores may be very large. If measurement is to be accurate, it is necessary to obtain responses characteristic of the individual. This is accomplished by including in each test a large number of items eliciting the same type of ability, and by utilizing several tests rather than merely one test.

At best, however, measurement merely samples the individual's responses. For a short period of time in a test situation the testee responds to a set of problems or questions. These responses are considered characteristic of his behavior, and the generalization is made that the testee would behave in the same way in all situations of a similar nature. Such a generalization is accurate only to the degree that the sample responses are representative of the individual's ability. It must always be kept in mind that the sample is an approximation, and that any generalization must be applied within this limitation.

Implications of Tests as Sampling Devices.—From the foregoing discussion it should be clear that any interpretation or meaning given to a set of test scores must be conditioned upon the accuracy with which the test samples the same ability in different individuals, the degree to which it samples the ability that one desires to measure, and the extent to which it is a representative sample of the individual's ability. The attainment of adequate sampling in each of these ways does not present insurmountable difficulties. An understanding that tests are sampling devices is necessary in order to counteract the blind faith in test scores frequently aroused in students and in officials in business and industry, who need and desire to use tests but who do not devote sufficient time to their study to realize that, like every tool yet invented, when utilized without critical understanding, tests lose their precision and usefulness.

POTENTIALITY VERSUS PROFICIENCY

Meaning of Terms.—As stated above, the determiners of the test responses are found in the native dispositions and past experiences of the testee. In psychological measurement for purposes of personnel selection and placement, there is no need to distinguish between innate and acquired factors. However, fundamental distinctions in the purposes of measurement already mentioned merit further consideration. One purpose of measurement is to describe what the individual can do at the time of testing, the emphasis being on the serviceable nature of actual performance. A second purpose is to estimate from the testee's responses the power he has to accomplish future growth and development, the emphasis being upon potentiality for later accomplishment. Several terms have been used to distinguish between these purposes. It is obvious that regardless of the purpose of measurement it is necessary to elicit some form of response from the testee.

The word *ability* is used in a very broad sense to mean power to perform. It does not imply that the power is actual or potential and makes no distinction between native dispositions and acquired experience. If the purpose of the measurement is to select an individual who is qualified to perform immediately in a given situation, the word *proficiency* is used. Proficiency refers to the testee's present accomplishments or achievements—what he actually can do at the time of testing. On the other hand, the word *potentiality* refers to dormant ability yet to be developed. The word *capacity* also is used in this sense. Both potentiality and capacity have a reference to the future and stand for the ability or power for further development and accomplishment. No distinction is made as to whether the potential is conditioned upon native or acquired factors. *Aptitude* has a similar connotation but generally refers to ability not contingent, or at least only to a small degree contingent, upon formal education, training, or experience.

Sample Items.—In Fig. 16 are shown several items from an aptitude test and several items from a proficiency test for streetcar conductors. Although scores on certain of the items in the aptitude test will be influenced to some extent by the amount of formal schooling and general experience, beyond a certain relatively low minimum increasing amounts of such education and experience probably will not have any great effect. The important point here is that previous experience as a streetcar conductor is not necessary in order to obtain a high score on the aptitude test. On the other hand, in order to obtain a satisfactory score on the proficiency test, experience as a conductor is necessary.

Difficulty of Measurement.—The measurement of proficiency is a somewhat simpler problem than the measurement of potentiality. To measure proficiency in a given task one can construct a test very closely simulating the task. The more closely the test situation reproduces the elements of the task, the more valid is the measurement likely to be. On the other hand the evaluation of potential ability requires the measurement of some present ability that in the nature of the case cannot be the same as the subsequent ability but must be so related to it that the present ability can be used as a predictor of the subsequent ability. The ability to be measured being a potential, it cannot be expressed in the form that subsequently is to be evaluated. Other abilities that have been developed and are expressible in present performance may be found to be closely related to the potential ability. In this case the proficiency in one area is used as an index of the most probable amount of potentiality in another area. Thus, high-school achievement may be used as an index of potentiality for college work. Great difficulty is often encountered in discovering proficiencies closely related to the potentiality to be measured.

Items from an aptitude test for streetcar conductors

Put a plus (+) between any of the following pairs of numbers that are the same and a circle (○) between any that are different.

648396____648396
960584____960684
396759____397659
104782____104782

Add or subtract the following numbers as indicated.

948693	105846	574106	473017
−938610	+285901	−396907	+185739

Put a check mark before the best answer in each of the following questions.

The best way to face when jumping off of a moving streetcar is toward:

____the front of the car
____the sidewalk
____the rear of the car

Items from a proficiency test for streetcar conductors

Put a check mark before the correct answer in each of the following questions.

What is the position of the farebox on the car?

____In pulling out of the carhouse, put it on the front end of the car.
____The farebox must be kept on the rear end of the car at all times.
____When leaving the car to get change, the conductor takes the farebox with him.
____When changing ends, the conductor puts the farebox in the sand box.

Where are number plates placed?

____Run number plates are placed on the side windows of cars.
____Run number plates are placed on the conductor's end only.
____Run number plates are displayed on both ends of the car.
____Conductor and motorman hang run number plates on left lapel of coat.

In punching the time on the transfers for "Owl" cars:

____Allow 3 hr. from end of line.
____Allow 15 min. after midnight.
____Allow 1 hr.
____After 12 P.M. punch "emergency."

FIG. 16.—Examples of items from an aptitude test and a proficiency test for streetcar conductors.

CLASSIFICATION OF TYPES OF TESTS

In view of the fact that psychologists have been devising tests for nearly half a century, it is not surprising that there are many different types. To try to describe all the different types of tests that have been developed at one time or another would be an impossible task. Perhaps the best way of obtaining knowledge about the different types is to classify them. Tests may be classified in several different ways, and in the following paragraphs the more important of these classifications will be discussed.

The Nature of the Trait Being Measured.—One major division of tests is in terms of the psychological traits which the tests are primarily designed to measure. It may be intended that the test measure ability of one kind or another, or it may be intended that the test measure some aspect of personality, temperament, or interest. Since measures of personality, temperament, and interest do not lend themselves easily to measurement through tests, questionnaires and inventories of various kinds ordinarily are employed to measure these characteristics. Because of the special nature of these devices they will be discussed in more detail later in this chapter.

It cannot be said, of course, that any test or inventory merely measures ability and not personality, or vice versa. Certainly both kinds of characteristics determine the scores on any test or inventory. Thus on a test designed to measure ability to follow complex directions a person without perseverance will obtain a low score. Similarly on a questionnaire designed to measure sociability a person who has only third-grade reading ability, but who, nonetheless, is sociable, will perform in an inadequate manner.

Objectives of Tests.—A test of ability may have either of two objectives as follows: (1) to predict how well a person will do on a job for which he has not had training in the specific procedures and work techniques utilized on the job, or (2) to estimate how well a person who has had such training will do on that job. The difference here is between potentiality and proficiency, which has already been discussed in detail.

Tests of potentiality or aptitude may be further classified. Some tests of this kind purport to measure a general aptitude and others a specific aptitude. Thus there are tests of general mechanical aptitude presumably measuring future success in any kind of job involving ability of a mechanical sort, and tests of general clerical aptitude from which success in any kind of clerical job is to be estimated. Specific aptitude tests, on the other hand, attempt to predict success in a specific job, as garage mechanic or file clerk. Naturally, aptitude tests will vary in the degree of their generality or specificity. The following jobs require tests of increasing generality: comptometer operators, business-machine operators, clerical workers primarily concerned with numerical operations, and, finally, general clerical workers.

In vocational guidance, or in those industrial organizations where the attempt is made to classify and optimally place the individual, it is very helpful to have knowledge of the person's particular abilities.

An organization in which there is a variety of jobs, some of which are mechanical in nature and others clerical, could well test all applicants with a test of general mechanical aptitude and one of general clerical aptitude to best fit the workers or applicants into the organization.

A further differentiation of proficiency tests may also be made. Proficiency tests may be classified into those primarily measuring job knowledge or information and those measuring job skill. In the first case, proficiency is measured by the amount of information about the job that the worker possesses, and in the second case by the amount of skill the worker displays in carrying out the job. Since the early proficiency tests for industry were developed for the skilled trades, they have come to be called *trade tests*, even though the occupation is not of a mechanical nature. Although most trade tests are, perhaps, measures of job information, many of them are truly tests of skill. Consequently the term *trade test* may be used to refer to either type of test.

Score	Expert bricklayers	Apprentices and helpers	Related group
15	xx		
14	xxxxxxxx		
13	xxxxxxxxxxxxxxxxx		
12	xxxxxxxxxxxxxxxxxxxxx		
11	xxxxxxxx	x	
10	xxxxx	xx	
9	xx		x
8	xx	x	
7		xx	
6		x	x
5		xxxxxx	
4		xxxxx	x
3		xx	xxx
2		xx	xx
1		xxx	xxxxxxxxxxxx
0			xxxxxxxxxxxxxxx
Number of cases....	65	25	35

FIG. 17.—Distribution of scores of three different groups of workers on job-information test for bricklayers.

Work-sample tests are examples of tests measuring job skill directly. In tests of this sort the worker is required to do exactly the same work that the job requires. Work-sample tests have been discussed in detail in an earlier chapter. It should be pointed out that there is an important difference between a job-skill test and a simple demonstration of proficiency. In a job-skill test the situation is exact and controlled, the problem is the same for all individuals, and performance is evaluated by comparison with established norms.

Although job-information tests classify men according to job knowledge, owing to the fact that the questions differentiate workers varying in experience, they also may be said to classify men according to job skill. In Fig. 17 are shown the distributions of scores on a job-information test for bricklayers made by persons varying in amount of experience on the job of bricklaying.[3] The validity of the test is clearly demonstrated by the fact that groups with more experience on the job earn higher scores on the test than those with less experience. In addition to the fact that scores on job-information tests are related to amount of experience, further evidence that they measure skill comes from the fact that the test scores are usually related to proficiency on the job. In Table 38 are shown the validity coefficients for various job-information tests, as indicated by the correlation between test scores and ratings of proficiency by supervisors for several groups of workers in an Army depot.[4] It will be noted that substantial correlation is found between test score and proficiency on the job in six of the eight studies.

TABLE 38.—COEFFICIENTS OF CORRELATION BETWEEN SCORES ON VARIOUS JOB-INFORMATION TESTS AND SUPERVISORS' RATINGS OF PROFICIENCY

Test	No. of cases	Coefficient of correlation
Magnetos	24	0.62
Warehouse (women)	150	0.43
Sheet-metal repair (women)	90	0.36
Sheet-metal repair (helpers)	82	0.34
Sheet-metal repair (men)	63	0.32
Service mechanics	130	0.31
Sheet metal repair (juniors and journeymen)	216	0.18
Warehouse	160	−0.03

Means of Response.—Tests may also be classified according to the manner in which the individual taking the test is required to respond. A broad differentiation may be made between verbal tests and performance tests. In verbal tests the response is either written or oral, whereas in performance tests the individual operates apparatus or machines, assembles parts, or performs other manual manipulations.

In certain cases job-information tests are administered in connection with the employment interview. In such cases the questions on the test (there may only be some fifteen or twenty questions) are read by the interviewer, and the applicant gives his answers by means of the spoken word. Such a test is an oral test. Classroom examinations are examples of written tests, since the response to the questions is accomplished by means of writing something down. Tests of finger dexterity, wherein the individual inserts pegs into holes, and tests of mechanical aptitude, where the task is to assemble simple objects, are examples of performance tests.

In most instances, verbal tests have an advantage over performance tests in situations where either can be used. They are less expensive and cumbersome. When the responses are written, the tests can be administered to large groups of people simultaneously. The major advantage of performance tests is that they afford an opportunity to observe the testee as he solves the problems presented to him. Often from such observation, information can be obtained relative to such factors as work habits.

Means of Administration.—Another way of classifying tests is on the basis of whether they are individual or group tests. Some tests, such as those requiring oral responses, can be administered to only one individual at a time. Other tests, as those requiring written responses, can be administered to large groups of individuals at the same time. From the point of view of testing time, the advantage of the group over the individual test is apparent. Furthermore it ordinarily requires a less skillful individual to administer a group test. However, all the advantage does not lie with group tests. As pointed out above, when individual tests are used, the personnel officer has an opportunity to observe the testee at firsthand and thus is better able to make ratings of the individual on other traits, should this be desired.

From the point of view of reliability and validity, neither test has an advantage over the other as far as the industrial situation is concerned. It sometimes is held that the confusion and social stimulation of the group testing situation markedly affects test performance and thus reliability and validity. There seems to be little support for this point of view, inasmuch as group tests have been devised as fully adequate in respect to reliability and validity as are the best individual tests.

Time Allotted.—In many tests the testee is permitted to work on the problems involved for a given time interval, whereas in others he is allowed to take as long as he desires. The former type of test is called a speed test and the latter, a power test. Speed tests may be further classified into time-limit and work-limit tests. In the former the individual is scored on the basis of the number of items completed in a given time interval, and in the latter on the basis of the time taken to complete a given number of items. In a speed test of typewriting, either the number of words typed per minute or the number of minutes required to type a certain amount of material can be used. In the time-limit method more items are included in the test than the best individual is able to complete within the time permitted. The time-limit method is the more widely used because of its convenience, the work-limit method being impractical when testing groups of individuals.

Although speed tests are advantageous from the point of view of administration, they are disadvantageous in one important respect. It has been found that older adults do not perform so well on tests depending primarily upon speed of response.[5] With older workers, therefore, speed tests may indicate a low level of ability not truly characteristic of the individual. In cases of emergency, as during the Second World War, when it is necessary to draw upon older individuals to fill labor shortages, the use of speed tests gives a false picture of the abilities of the individuals. In such instances, power tests, where speed is not at a premium, are found to be far more useful.

Standardization.—Another general basis for classifying tests is in terms of the amount of information about the tests that will prove useful in the interpretation of the scores. The terms commonly used for distinguishing tests on this basis are *standardized* and *nonstandardized*. However, there is no clear-cut division of tests with regard to standardization as the use of these two terms of opposite meaning would seem to indicate. Generally speaking, the standardization of a test involves setting up the best possible conditions for getting the most from the test, and the constructor of the test is usually responsible for establishing these conditions. It is obvious that standardization exists in degrees or amounts, and that the more adequate the conditions set up by the constructor, the better the standardization. Classifying tests as either standardized or nonstandardized ignores the continuousness of this characteristic of standardization.

CHARACTERISTICS OF A GOOD TEST

Thus far in the discussion, several features to be desired in tests have been mentioned. It will not be amiss to reconsider these again briefly and to discuss other characteristics to be looked for in any test contemplated for practical utilization. It should be stated at the outset that one cannot expect every test already published to measure up to the standards to be presented. Neither will the initial attempts of a test research program in a given business or industry always result in instruments achieving all the standards. However, there is ample proof from past achievements in testing, not only in the academic field, in which tests have been developed to a very high level of effectiveness, but also in the fields of government and business and industry, that tests of high predictive value can be constructed if adequately trained personnel and time and funds for needed fundamental research are available. In the following chapter some aspects of such a research program are discussed.

Validity.—Whether one desires to use a test designed for the purpose in hand, to adapt for a new purpose a test constructed for a different purpose, or to construct a completely new test, the first characteristic to look for or to achieve is that of high validity. Inasmuch as the forecasting of an individual's subsequent performance from his test score is involved in the use of nearly every test, validity is synonymous with effectiveness in prediction. As was indicated in a previous section, predictive value must be stated in terms of a definite criterion measure of job proficiency. Even a more specific statement can be made. In selection one might say that a test score should successfully predict an applicant's performance on a specific job as measured by a certain criterion after a definite amount of training of a specific type has been given. Actually this precise, concrete, factual kind of situation is the one in which the employee executes his work, receives his satisfaction, and contributes to the organization and therefore should be the type of situation to which any prediction by means of a test score is referred.

The level of predictive effectiveness to be accepted must be determined for each specific situation in which a test is to be utilized. Whether or not a test is acceptable is determined in part by the effectiveness of the methods already in use. If a testing device does not significantly improve prediction of future job proficiency above that which current procedures achieve, it certainly does not merit adoption. It is obvious then that whether a test will be judged valid or not is conditioned upon the success attained by the methods the test is to supplement or supplant.

It is sometimes difficult to determine whether a test would effect an improvement without actually trying it out. Very few organizations have conducted research studies to determine the success of current nontest procedures, so that a quantitative statement of the predictive value of these procedures is seldom available. The only standard against which the test can be compared is that of chance. It is possible at the end of a validation study to state what improvement over chance success is obtainable from using the test. This expected improvement is conditioned upon the percentage of applicants making good on the job when no testing program is used, the available supply of labor from which new employees are to be chosen, and upon the degree of correlation between scores on the test and subsequent success on the job.

Before leaving the topic of validity, brief mention should be made of what is known as *face validity*. The latter refers to the apparent validity or apparent goodness that a test has because it demands from the testee a response that is similar in nature, or appears to be related in some observable aspect, to the subsequent performance to be predicted. For example, if the task is to predict ability to drive a truck, and the test consists of an apparatus simulating the driving compartment of an automobile with steering wheel, clutch, and brake, which are used in responding to various signals, then the test is said to have face validity. Face validity is useful on several counts but primarily as a means of enlisting favorable attitude. Testees who know the job for which they are being considered are quick to detect any resemblances between the test situation and the job situation, and most testees are favorably disposed toward any test in which they find this apparent similarity. In the end, however, the validity must be determined in terms of predictive effectiveness.

Reliability.—Another characteristic desirable in a test is a high reliability. Reliability refers to the consistency with which the test operates in repeated trials. Any measurement, regardless of the precision of the measuring instrument, will always be subject to a certain amount of error. A person measuring the length of a 10-ft. table to the nearest 0.1 in. will not get identical lengths each time the measurement is repeated. If a person is given two forms of the same test on different occasions, the two scores will not be the same. His performance on the tests is partly a function of his physical condition, his incentive and attitude, distractions present during the testing, and other similar factors. Such factors would not be exactly the same on the two testing occasions; consequently some difference in the individual's two scores is to be expected.

In general the smaller this difference is between two measurements of the same thing using the same instrument, the greater the reliability of the measurement. Reliability, then, becomes a function of the consistency of measurement; the more consistent it is, the more reliable it is. Usually, if measurement is consistent, if it can be repeated with very nearly identical results, we assume that the measurement is accurate. Accuracy of measurement then is sometimes used as a definition of reliability. The fact that a measurement is reliable or consistent does *not* mean that the device is accurately measuring that which it is expected to measure. A so-called "aptitude test" may give consistent results, in the sense that individuals upon repeating the test may get about the same scores, but this consistency in no way indicates the extent to which the test actually measures the aptitude intended. The latter is the problem of validity or predictive effectiveness. If the results are consistent, however, it is assumed that what is being measured is being measured reliably or accurately.

Reliability is of considerable importance in testing. The value of any score in psychological measurement lies in the fact that, on the basis of that score, an individual's performance can be evaluated in relation to the performance of others. This evaluation may take the form of ordering the scores in terms of amount, thus comparing individuals in terms of their ranks, or more exact and refined methods may be used for indicating the relative differences between the scores of various individuals. Regardless of the technique used, test scores form the basis for drawing inferences and making predictions about individuals who obtain different scores, or about groups with different mean performances. It is apparent that for these predictions or inferences to be of any value the initial measurement must be reliable. To attach any importance to a test score, it must be known that when A gets a score higher than B the difference between the two would be similar if the test were repeated under similar conditions.

It is unusual for each of a large group of individuals to get a score on a retest identical with the score on the original test. However, a prediction can be made of the most probable score on the retest, and certain limits can be set up within which the second test score will fall with a known degree of probability. The smaller these limits are, the more reliable the test, and the more confidence one can place in the score as being an accurate index of the individual's ability. The importance of reliability therefore lies in the fact that it gives information relative to the amount of variation to be expected in an individual's test score from factors other than those measured by the test. If a test is not reliable, then no confidence can be placed in the stability of the individual scores.

The question arises as to the degree of reliability to be demanded in tests that are to be used in practical prediction. In the majority of instances when tests are used for the selection and placement of workers, they will be used for the evaluation and placement of individuals and not primarily for the evaluation or comparison of groups of individuals. Consequently a high standard of reliability should be demanded. Usually the reliability of a test is measured by means of correlation and expressed as a coefficient of reliability. Common usage dictates that a test should have a reliability coefficient of 0.85 or higher if it is to be used in individual diagnosis. For most purposes this is to be interpreted as a minimal value of the reliability coefficient, and in any given case further research should be continued in order to increase it to 0.90 or higher.

Coverage of Job Criteria.—The characteristics of validity and reliability, already considered, can be determined only after the construction of the test has been completed and the test administered to a trial group of subjects. Other factors must be given attention as the test is in the process of construction; these will also assist in evaluating a new test or one devised for a purpose different from the one for which it is being considered. Coverage of the criteria is a factor evaluated through logical and psychological analysis and therefore is not dependent upon a formal tryout of the test. By this characteristic is meant a thorough comparison of the test situation with the job situation in terms of the psychological abilities, aptitudes, traits, interests, skills, and other factors conditioning success on the job. Two problems are involved: first, a determination of the degree to which the various psychological factors are covered by the test and, secondly, the determination of the weight or importance of the factors. It is obvious that the greater the number of criterion factors covered by the test, and the more closely the weights of these factors in the test correspond to the importance of the factors in the criteria, the more likely it is that the test will prove a valid one.

The first step to be taken in making the comparison is to obtain accurate and thorough job and worker analyses. Through a study of these, the test constructor learns what psychological factors are present, which of the factors are amenable to measurement by means of tests, and among these measurable ones the relative importance of each. If a test is to be constructed, then each factor is considered relative to the type of item to be used in measuring the particular factor. Each factor is assigned an importance in the test corresponding to its role in the job criteria by adjusting the relative number of items for the part tests, or by the particular method of scoring utilized, or by the weights assigned the different scores. If the problem is to evaluate a test already available, then a careful analysis of the test is made to determine the degree to which it includes the psychological factors essential to the job. Following this, through a consideration of the number of items, of the weights assigned the items, and of the method of scoring, the various parts of the test are weighted to correspond to the relative importance of the factors on the job.

Suitability of the Test for the Group under Consideration.—In the selection or design of a test, it is important to bear in mind the nature of the group on which it will be employed. The suitability of a test may be indicated in a variety of different ways. The distribution of scores is possibly the simplest index. If the test is too difficult, then most individuals will tend to get low scores, whereas, if it is too easy, they will tend to get high scores. The difficulty of a test should be so gauged that the scores show a reasonably wide distribution. In Fig. 18 are shown the distributions of scores of a group of men and a group of women on a 40-item test designed to measure mechanical aptitude. The scores for the women show a wide distribution indicating that in terms of difficulty, at least, the test was satisfactory for them. On the other hand the scores for men cluster closely around the upper limit of the test, indicating that it was too easy for them.

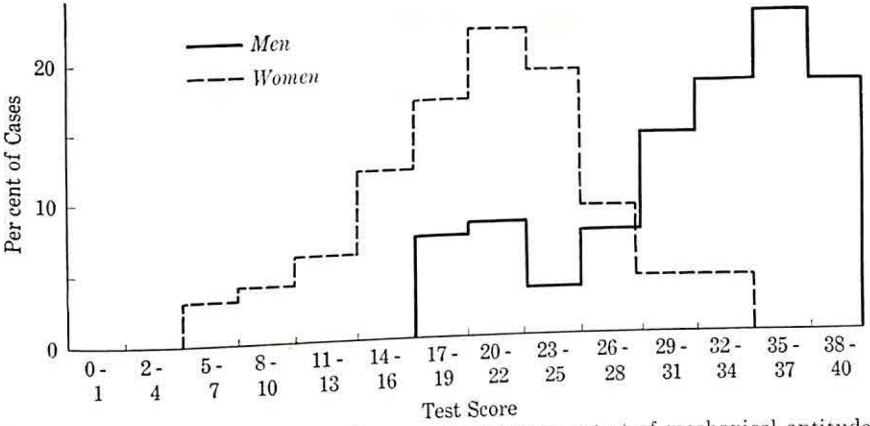

FIG. 18.—Distributions of scores of men and women on a test of mechanical aptitude.

It has already been pointed out that, in general, speed tests are not suitable for older persons. To some extent this is also true for individuals with language handicaps. For the latter type of individual, nonverbal tests would be more appropriate, because they do not penalize for the language deficiency. In many tests the language is cast in terms of the social culture of the workers under consideration. The lower grades of workers will not react favorably to tests involving "highfaluting" words. It is always necessary to fit the test to the group in as many ways as can be foreseen.

Item Characteristics.—Other features of a test to be examined in determining its usefulness have to do with the nature of the individual problems or questions comprising the test. The amount and nature of the testee's response are supposed to reflect the amount and nature of the ability he possesses. Phrased differently, the response is a function of the individual's ability—the better the response the greater the ability. If there are two testees and one gives a higher quality response than the other, he is said to have more ability. Inasmuch as both reacted to the same set of stimuli—the test situation—the difference in performance then represents a difference in ability. Now if this functional relation between response and ability is to hold, the stimulating situation must be constant for all testees. Any feature of a test that has a variable stimulating effect on different individuals vitiates this necessary functional relationship. Constancy of test stimuli then is an essential condition for accurate measurement.

In pencil-and-paper tests the test item is the exciting stimulus which elicits the response to be measured. These stimuli are presented in verbal form, and constancy of stimulating effect is especially difficult to achieve. Here the nature of the stimulation is dependent upon the testee's interpretation of the items—the meanings the statements have for him. It is common knowledge that the same word has more than one meaning, and that different individuals apply different meanings to the same word or phrase even though interpreting it in identically the same objective context. It is obvious that special care must be exercised in constructing test items so that singleness of meaning will be achieved.

Norms.—The standardization of a test is dependent, in part, upon the norms that are available for it. Norms refer to a distribution of scores on a test that can be used as a basis for interpreting and evaluating an individual's performance on that test. Usually the test constructor, after trial use of the test on different groups, furnishes the scores made by these groups to all users of the test. Several factors determine the usefulness of these norms. First, other things being equal, the larger the numbers of cases the more reliable the norms. Until several hundred scores have been obtained, the norms usually are considered to be unstable.

A second factor concerns the available information on the level of skill characteristic of the workers whose scores are used in the preparation of the norms. Frequently in standardized tests the description of the norming population is not adequate, and without adequate information about the level of skill of this population the user of the test is unable to assay the test accurately for the specific use that he needs to satisfy. It is not sufficient to say, for example, that the average score of 50 carpenters on a test is a given amount. The classification of carpenter might contain individuals varying widely in ability from apprentices and helpers, who can merely drive nails and saw boards, to master carpenters, who with a given set of blueprints can proceed to construct a complete building. Unless the degree of skill and knowledge of the group of carpenters is given, the user of the test cannot make an accurate evaluation.

A third factor concerns the kinds and number of different groups on which the scores are available. As pointed out several times, the specific use to be made of a test forms the basis for any evaluation. Unless there is a normed population, similar to that of the group for which the test is to be used, the tester is unable to learn how valuable the test might be for his purposes.

There are two general types of norms. One is called *general population norms*, which is a distribution of scores made by workers in a wide variety of jobs. The persons whose scores go to make up these norms are chosen so that they represent a cross section of the total employed population of the entire country.

TABLE 39.—NORMS ON A TEST OF EYE-HAND COORDINATION FOR A REPRESENTATIVE SAMPLE OF EMPLOYED WOMEN AND FOR A SAMPLE OF WOMEN TYPISTS

Earning lower scores, per cent	General employed population*	Typists†
90	174	186
80	162	178
70	153	171
60	147	163
50	140	157
40	133	150
30	126	144
20	115	134
10	104	123

* Includes 450 cases.

† Includes 129 cases.

The second type of norms comprises scores of individuals from those specific population groups for which the test was designed and for which it has definite usefulness. In Table 39 are shown the norms on a test of eye-hand coordination for a group of 450 women who formed a representative sample of the adult employed population of women and for a group of 129 women typists. It will be observed that the performance of the typists on this test was superior to that of the general population. Thus, only 25 per cent of the typists earned scores lower than 140, whereas 50 per cent of the general employed population earned scores lower than this. This is not surprising in view of the fact that this test has some validity for predicting speed and accuracy in typing.

Standardization.—Finally the usefulness of a test is determined by the extent of its standardization. Any knowledge about a test that is in its favor and has resulted from empirical application of it improves the standardization. Definite and prescribed methods and procedures for administering a test and for scoring it are part of the standardizing process. Likewise, giving the test to many hundreds of individuals and establishing test norms for different groups are important aspects. However, the most significant fact about a test, insofar as the practical situation is concerned, is whether or not it has been adequately validated for the specific purpose for which it is to be used. Because so much emphasis has been placed upon the need for standardization, a more detailed consideration of this concept is warranted at this point.

Three rather widespread notions about standardized tests need discussion. One notion is that a test is a good test because it is standardized; the second is that a standardized test is better than a nonstandardized test; and the third is that a test is standardized when a scoring formula and a time limit are described and a few hundred scores obtained on the test. Difficulties arise because of a rather loose interpretation of the term standardization, or because of a failure to evaluate a test in terms of the specific purpose for which it is needed. Concerning the first notion, it should be said that a test is not a good test just because it is standardized, but rather that it is a good test if it predicts or measures the ability or traits for which it is to be used, *i.e.*, if it is valid. However, a test in which the administrative directions, time limits, scoring procedures, etc., are adequately worked out, *i.e.*, standardized, will have a higher chance of proving valid than if it were not so constructed.

The second notion, that a standardized test is better than an unstandardized test, is true or false depending on what is involved in the standardization. Suppose that there are two tests for selecting streetcar motormen. The first involves arithmetic ability, social perception, and simple speed of reaction. The tests are timed exactly, the administrative directions are worked out to the last detail, and scores are supplied on 10,000 motormen in one transit system who are considered successful on the job. The second test measures eye-hand coordination and speed of perception. The administrative directions are rather general, the timing of the test performance is crude, and norms are available on only 200 motormen. Now, in addition, a validity study was conducted on these 200 motormen. They were given the tests as applicants and then hired. Later such criteria as number of accidents, time lost on runs, and number of public complaints were obtained, formed into a score of proficiency, and checked against the test scores. The coefficient of correlation between the two tests and the subsequent measures of proficiency as motormen was 0.54. Some authorities would consider the latter test nonstandardized and the former very well standardized. However, for the purpose of selecting streetcar motormen, the second test is to be preferred to the first.

The third notion involves the meaning of standardization more directly. A survey of the standardized tests that might prove useful in business and industry shows that, with a very few exceptions, standardization refers principally to administrative routine and norming. Validity is not usually part of the procedure, and, in most cases where it has been considered, no great emphasis is placed on it. In terms of the practical usefulness of any test—whether called "standardized" or "nonstandardized"—the question is whether the test measures or predicts the ability for which it is to be used. Surely, if great care is taken in perfecting the mechanical features of the test, even greater concern should be shown in determining whether the instrument actually does the work for which it is designed. Of all features of standardization, validation would appear to be most essential.

PERSONALITY MEASUREMENT

Success on a job is not solely determined by ability but, in part, is attributable to traits of personality, character, and interest. A number of investigations, some of which will be described in a subsequent chapter, have shown that separation from a job is frequently due to deficiencies in personality. It is therefore necessary to consider various methods that have been devised for evaluating these more intangible factors.

Definition.—By personality is meant those traits of the individual, or aspects of his behavior, that have emotional, social, motivational, or moral connotations. Thus one speaks of the personality traits of stability, extroversion, perseverance, and honesty. Numerous authors have attempted to classify the various aspects of personality, and from a theoretical or systematic point of view such classifications are useful. For the problem at hand, however, it is unnecessary to consider such theoretical problems, and it will be more fruitful to consider the different methods that have been employed in the measurement of personality. In the following paragraphs we shall consider the two methods of measuring personality commonly employed in industry, viz., tests and questionnaires.

Tests.—In earlier discussions of tests it was pointed out that a test is a stimulating situation, designed to elicit behavior of a particular sort. The resulting measurement of the individual will not reflect his ability in a single, independent, and unitary trait, but rather will draw upon many abilities. Thus a test might be designed that would draw principally upon personality traits, rather than upon one or another of various abilities. For example, suppose a job required emotional stability in a rapidly changing situation—the job of taxicab driver might be considered as an example. In order to measure this ability one might employ a test in which the individual is presented with a variety of stimuli, such as lights flashing on at different points, to which he is required to make differential responses by means of a set of keys and levers. In the test situation the lights appear for very short intervals and follow closely one after the other, thus necessitating rapid responses. It is apparent that an individual without a great amount of emotional control would make a poor score or might even be unable to complete the task.

It is obvious in tests such as the one just described, that, although proficiency in a task is being recorded, personality is also being measured in a negative and indirect sort of way. That is, persons with an undesirably low amount of what might be termed "emotional stability" would be likely to manifest poor performance on the test. Tests such as these have not been widely used in industry, at least in the sense of being primarily tests of personality. Tests calling for rapid integration of stimuli and responses have been employed but generally are given such titles as "tests of eye-hand coordination" or "reaction time." It must be accepted that such tests do not simply measure ability but to a considerable extent also give indications of personality. Thus the criticism often directed against the use of tests in the selection and classification of workers, to the effect that the tests do not measure personality, is a fallacious criticism. Many personnel officers, realizing the importance of personality factors in the successful performance of jobs, refuse to use tests because they believe them to measure only ability. Such a position cannot be logically defended, particularly when the test scores are found to be valid predictors of job success.

Questionnaires and Inventories.—Perhaps the most common way of assessing personality, at least when large numbers of individuals are involved, is by the use of questionnaires or inventories. These questionnaires typically consist of a series of questions directly concerned with personality either in its behavioral or mental aspects, such as the following:

> Have you ever felt uncomfortable in a social situation?
> Do you often feel just miserable?
> In talking to large groups of people do you get embarrassed?
> Do you object when a person pushes ahead of you in a waiting line?

Depending upon the particular questionnaire, the answers called for might be simply yes or no, or some qualification in terms of degree or frequency might be permitted.

In the preparation of personality questionnaires, the first step is simply to collect questions that seem to have some pertinent relation to the personality trait in question. Various sources of information may be used. Thus Woodworth, in assembling a test for use in the measurement of general emotional adjustment, began by studying case histories of emotionally unstable individuals and recording their reported symptoms.[6] From these symptoms, questions were prepared that could be answered in a yes-no fashion.

The second step in the preparation of a personality questionnaire is validation. An all too common method of validating personality questionnaires is by proclamation. The constructor of the test states that his test is valid because the items it contains appertain directly to the personality trait in question. Thus a "sociability inventory" is claimed to be valid simply because it contains questions relative to behavior, interests, and feelings in social situations. Usually such questionnaires are based on some "theory" of personality, and the claim is made that a given inventory is better than most others because the theory on which it is based is a "better" theory. As a science, industrial psychology will be willing to consider such theories as springboards for research, but it cannot accept them as scientific proofs. Various methods of validating personality questionnaires have been employed, such as comparing the scores they yield with ratings on personality, or observing the differences in scores of groups of individuals whom psychiatrists or clinical psychologists have diagnosed as "normal" and "abnormal" with respect to the trait in question.

Special mention may be made of one particular type of questionnaire that falls in this general area, viz., the interest inventory. The questions in this type of questionnaire usually have to do with likes and dislikes with respect to different occupations, activities, amusements, school subjects, etc. The person answering the inventory may be asked to state whether he likes, dislikes, or is indifferent to each of a series of items, or he may be asked to choose which of two items he prefers. The items shown in Table 40 are typical.

TABLE 40.—EXAMPLES OF ITEMS IN AN INTEREST INVENTORY

For each of the following, circle L if you like that kind of work or school subject, circle D if you don't like it, and circle I if you are indifferent to it or don't know.

L I D Architect
L I D Barber
L I D Machinist
L I D Typist

L I D Algebra
L I D Biology
L I D History
L I D Mathematics

In each of the following pairs check the one you would rather do.

____ Repair a clock
____ Draw a picture

____ Meet new people
____ Read a book

____ Play baseball
____ Play solitaire

In such an inventory, questions that presumably indicate interest of a given kind are counted together to give a score indicative of that interest. In validating the inventory, persons in a particular occupation are given the questionnaire and their scores in various interests determined and compared with those of individuals in other occupations. Evidence of validity is obtained when a group of interests is found that appears to be characteristic of successful individuals in a given occupation, their scores on these interests being higher than the scores made by persons in other occupations. For example, garage mechanics probably would indicate that they have some interest in the occupation of machinist and none in that of actor, that they prefer physical to social sciences in school, and that they would prefer to find out how a radio works than lecture to a group of people. The opposite preferences on these items would probably be indicated by a group of salesmen.

The validity of the personality or interest inventory will be a direct function of the honesty and accuracy with which the individual answers it. A person's performance on a test or inventory cannot be expected to be divorced from the purposes and motives that actuate him to take it. In a test a "good" score is a high and/or accurate one. This the individual knows, and since he wants to make the best showing possible, he will perform as well as he can. In the case of personality and interest inventories, however, a good score is not so defined. It is apparent that an applicant for the job of salesman will not answer "no" to the question "Do you like to meet people?" The individual taking the inventory therefore, knowing that his performance is going to be used for determining his fitness for the job, will be desirous of making a creditable performance. He is consequently very likely to falsify his responses if it appears desirable. Even if he does not deliberately lie, it is likely that his responses to the same inventory would be different on two separate occasions through unconscious bias, perhaps, when applying for different jobs.

Sometimes claims are made for particular inventories to the effect that falsification on them is impossible. Such claims are not generally borne out by either experience with questionnaires or the experimental evidence. Often, when the possibility of falsification is admitted, the claim is made that it can be detected. Even if such detection were possible, it would take considerable time to do it for each individual testee, and the responses of every person to whom the questionnaire was administered would have to be carefully examined. In addition this examination would have to be done by a highly trained professional person and could not be done by the ordinary personnel interviewer or clerk.

This does not mean that personality and interest questionnaires have no place in industrial personnel procedures. They are particularly helpful in placement. Suppose that an applicant was assured of being hired and the only remaining problem was to select the particular type of work for him. If he understood that the remuneration and promotional possibilities were the same in all available openings, then it would be clearly to his advantage to give honest responses. The more accurately he would answer, the greater would be his chances of correct placement and success.

In those situations where the individual is seeking guidance or counsel, questionnaires and inventories will be very helpful. Even here there will be certain limitations. If the questions involve obvious comparisons or choices, no more information will be obtained than could be obtained from an interview. The questions must get at more subtle manifestations of personality and interest and must cover a wide variety of topics. Even then it is necessary to obtain indices of validity through correlations with pertinent criteria.

Perhaps the best example of a good inventory is the Strong Vocational Interest Blank.[7] It was not designed specifically for use in selection but rather for use in counseling and guidance. The items in this inventory cover a wide variety of activities and situations. The norms and validation are based upon very large numbers of cases. The establishment of norms and validation has been a continuing process, and the result has been an instrument of exceedingly high value when used correctly.

It is perhaps pertinent to note that the Strong inventory, which has an excellent reputation among professional persons, differs in three very important respects from certain other inventories. First, the scoring key for the inventory is not secret but is available to any professional person; secondly, the evidence relative to validity is openly published in professional journals and books and is available for all to see; and, finally, perfection or even near perfection is not claimed for the inventory. There are other personality and interest questionnaires similar to the Strong inventory in these respects, and like the Strong inventory they are generally offered as tools for use in guidance and research, and are not offered to industry as the *sine qua non* of personnel selection methods.

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CHAPTER VII

THE EVALUATION OF TESTS

The evaluation of a test should never be based on the judgment of experts. During the various steps involved in constructing a test, many questions have to be settled by appeal to expert opinion and armchair speculation, but these decisions always should be checked empirically during the process of validation. In this process, objective, scientific procedures displace subjective opinion, and the test stands or falls in terms of empirical fact.

The method involves giving the test to a group of individuals for whom some measure of job proficiency is available. The test scores are then compared with the job-proficiency scores. If individuals scoring high on the test also receive high proficiency scores and those scoring low on the test receive low proficiency scores, then the test is considered to be predictive of job success and is retained for subsequent use. If this condition does not hold, *i.e.*, if both high and low test-scoring individuals receive proficiency scores scattered throughout the entire range from low to high, then the test is discarded.

TRIAL GROUPS USED IN VALIDATING TESTS

Two General Procedures Used in Validating Tests.—For most tests the initial validation study is usually made on workers already employed on the job. The reason for this is that criterion data are forthcoming in a short period of time. No time is lost in waiting for the testee to be trained and adjusted on the job as is true when applicants are used. Several limitations to this method will be discussed later.

The second general procedure is to test a group of applicants before they are placed on the job, and then check their test scores against their later proficiency. The ideal setup is to have the applicants placed on the job on the basis of procedures then in use and not to utilize the test scores in any manner in selecting the successful applicants. In this way there will be a wider range of test scores among the workers, and a more adequate notion can be gained of the differentiating power of the test. If the low-scoring individuals are never placed on the job it is never possible to learn the full extent to which the test would predict job proficiency.

The most important requirement imposed on the trial group of subjects is that it is representative of the group on which the test eventually is to be used. The specific job for which predictive indices are needed must be kept in mind in selecting this trial group. The testees should be of the same age and sex, have similar job interests and attitudes, and in other respects approximate the general characteristics possessed by those individuals upon whom the test will be used. If the validation results are to hold true for subsequent samples, then the initial trial groups must be representative of these later samples.

The two procedures described above can be utilized in validating tests for most of the purposes for which tests can be used in industry. Because tests have been used more frequently for selection purposes than for any other, special attention will be given to problems encountered in the validation of selection tests in the discussions that are to follow. It should be remembered, however, that the principles to be explained in this and the following sections apply, by and large, to the validation of any test, regardless of the purposes for which it is being constructed.

Using Old-established Workers in Validation.—As stated above, in order to get the most accurate results, a validation study should be performed on a group of testees representative of those on whom the test eventually will be used. In using a group of employed workers to validate a selection test, this principle is violated, because workers differ markedly from applicants relative to their ability to do the job. Workers are not similar to applicants in training, experience, and age, and very likely are not similar in terms of job interest and attitude. It is apparent therefore that the results to be obtained from such a validation study might differ significantly from those to be obtained from a group of applicants.

When established workers are used, the coefficients of correlation upon which the prognostic power of the test is based will in most instances be lower in value than if a group of applicants were used. Likewise, if several tests are being validated, and the problem is to discover a method for combining the tests in order to obtain the greatest effectiveness from the battery, then the results again will differ from those that would be expected from a study of applicants. The weights determined from a group of workers will be somewhat different from those obtained from a group of applicants. Any norms established will also be in error. The distribution of scores on the test will not be the same as if the testees used were just applying for the job. Consequently any critical scores established must be considered wholly tentative and should be corrected in the light of the test distributions obtained from applicants.

It is not to be presumed, however, that little information is gained from a validation study on old-established workers. On the contrary, it is almost certain that, if a test stands up under this type of validation, it will have even more predictive power than indicated by this group when it is used with a group of applicants. This argument becomes obvious when given a little thought. Any measuring device is more successful in revealing large differences than in revealing small differences, when both come within its range of application. A person is more successful in discriminating large differences than small ones in any attribute such as size, weight, color, sound, etc. Granted that the items of a test are measuring job proficiency, it follows that they will be more successful in revealing larger differences than smaller ones. Consequently, if a test is shown to be valid on a group of workers, it means that it is capable of distinguishing varying amounts of ability through a somewhat restricted range; and, inasmuch as the variations in ability will be greater among applicants, the test will have greater discriminatory power when used with them.

If the test shows a low predictive power on a group of established workers, this is not a sure sign that it is worthless. Effectiveness of prediction is to be interpreted in terms of degree and not as an all-or-none phenomenon. Even a test with a low amount of prognostic power, as determined on a worker group, may show a sufficient increase in power to be effective on an applicant group after its items are examined individually and improved.

It is important to keep the fact in mind that limiting conditions are imposed on the test data when a group of worker testees are used, but that in general these conditions depress the effectiveness of the test as a selection device. These facts should enter into any interpretations resulting from the statistical analysis of the test results. It must be realized, however, that sooner or later the validation of the test must be made on a group of applicant testees, even though acceptable prognostic power is demonstrated in the worker group.

Using Applicant Workers in Validation.—Inasmuch as every test must be validated on testees who are representative of the group of individuals on whom it is to be used, applicants should be the group upon whom the final validation studies are made. To be completely representative of the general group of applicants, the testee applicants should be selected at random. One way of doing this is to test every applicant who presents himself to the employment office during a certain period of time, provided that for this period of time no peculiarity of the labor market occurs to make the sample of testees unrepresentative of the applicant group. If possible, as many as several hundred applicants should comprise the validation group.

The test scores should not be used as part of the selection procedure in determining which applicants should be placed on the job. If it is feasible, all applicants who are tested should be employed, at least temporarily. Instruments for measuring the criterion should have been prepared and should be set to functioning as soon as possible. Any criterion scores that can be obtained during the training of the applicants should be used. During the testing of the applicants, data should be gathered on such factors as age, sex, training, and experience so that studies can be made later of the importance of these variables in determining the scores on both the test and the criterion measure.

ESTABLISHING ADEQUATE CRITERIA

The Need for Criteria.—As a preliminary step before administering the test, it is essential to determine whether valid and reliable criteria of job proficiency will be available for the group of testees. The importance of criteria cannot be overemphasized, because the evaluation of the entire testing program depends upon them. It is a good policy to start working on the measurement of job performance as soon as the decision to have a testing program is made. This then gives time for working upon criterion measures while the construction of the test is in progress.

It is absolutely necessary that the test constructor be given assurance right from the beginning that measures of job proficiency will be available. One of the authors, together with a collaborator, conducted a test-construction program that, when it was developed to the point of validation, had to be abandoned because criteria were not available. The task was to construct tests for the selection of aviators for one of the government services. The investigators were assured that those individuals who were to be tested would continue on to pilot training school, and that there would be available complete records of the pilots' proficiency during training, which could be used for obtaining criteria. Several tests were constructed and then administered to 100 trainees. At the end of the pilot training period, copies of the trainees' flight proficiency records were requested from the school authorities. It was then learned that these records could not be made available. If in examining a group of workers as possible testees there is reason to believe that adequate criterion scores will not be obtainable, then that group should be dismissed from further consideration.

The securing of criteria is fraught with difficulties. As already pointed out in Chap. III, the procedures for obtaining adequate criteria are fairly technical and require considerable expenditure of time and effort. These procedures, however, should be carefully followed if adequate criteria are to be obtained for the validation of the test.

Characteristics of Criterion Measures.—Although the important characteristics of criteria have been discussed in detail in Chap. III, it might be well to review briefly certain characteristics particularly pertinent to test validation.

Criteria should be accurate measures of job performance. They should evaluate the essential tasks performed on the job. Whenever possible, they should include the same characteristics of job proficiency as are measured by the tests. Job performance is complex. If a test constructed to measure certain job aspects is checked against a criterion measuring entirely different aspects, a true estimate of validity is not obtained. A further important characteristic is that the criteria should be quantitative in nature. This is not always easily achieved, since some organizations do not keep quantitative performance records of their employees. Quantitative scores are less subject to human error and provide a more accurate discrimination of differences in proficiency.

Criterion measures for different workers must be comparable; *i.e.*, within the testee group, all scores should reflect the same type of performance with the same degree of accuracy of measurement. The problem of adjusting scores of different individuals so that they will be comparable arises from the fact that not all the workers are doing exactly the same tasks. For instance, in a given group within the same department not all individuals will be working on the same type of machine, and as a result measures of their absolute output will not be comparable, owing to machine differences. Accurate differentiation of the workers in their job proficiency cannot be achieved unless the basis of discrimination is directly referable to differences in ability and not to such factors as the nature of the work, machine differences, etc.

The range of proficiency of the workers in job performance should be as large as possible. The object of any selection test is to separate the potentially good workers from the potentially poor workers. If only the best workers or only the poorest workers are selected for the trial validation, then the range of job proficiency scores is markedly restricted. In such a case, severe requirements are imposed upon the test, for it must differentiate between a good worker and a better one or between a poor worker and a very poor one if it is to be valid. Actually this is not the purpose for which the test is designed, and therefore using such restricted groups is not justified in a validation study.

If possible, the validation group should contain individuals at the various levels of job proficiency in about the same proportion as they are found on the job. If 25 per cent of the workers are excellent, 40 per cent good or average, and 35 per cent mediocre or poor, then the same proportions should be utilized in the trial group. In doing this a better notion can be obtained of what the test will do in terms of differentiating job proficiency, as that proficiency varies in the workers actually employed on the job, instead of in some hypothetical population of workers.

PROBLEMS OF ADMINISTRATION

Enlisting the Cooperation of the Testees.—It is not always easy to get the full cooperation of a group of old-established workers for a validation study. There is a very strong dislike among adults toward exposing themselves to situations in which their abilities are to be evaluated. Especially is this true when there is competition such as exists in a group test situation. In spite of the fact that their test performance will not affect their job standing in any respect, most workers will approach the test situation with a certain amount of trepidation. The problem of establishing the correct attitude and incentive toward the test is more difficult than in the case of applicants, who are motivated to cooperate to the best of their ability because their chances of being placed on the job rest upon the amount and quality of their test performance.

Various attitudes on the part of the established-worker testees will be found to affect their performance. The anxiety incident to being examined has been mentioned. In some cases the attitude will be that of fulfilling only the mechanical requirements of the test. That is, the worker will come to the test and go through the motions of answering the questions, but he will not give a performance representative of his ability. On the other hand, other workers will feel that the test results may be used for or against them, and they will work doubly hard to make a favorable impression. Some of them may even carry this attitude over to their job and try to improve their pace of work, thinking that in the future they may be scrutinized more closely as a result of their test performance.

About the best means available for establishing adequate rapport with worker testees is to give them an accurate account of the purposes of the testing program and to make the test instructions comprehensive and understandable, so that the worker gets a correct notion of just what is wanted of him. One important step is to assure him that the test results will in no way affect his job status. If possible, the test constructor should be given full control over the use of the scores so that he can assure the workers that their supervisors or foremen will not have access to them. A further incentive can be an offer to interpret the scores to them after the experiment is completed. To avoid influencing any criterion data being assembled, the workers should not know their scores until the job-performance measures have been collected. Cooperation must be on a voluntary basis, and the workers must be assured that refusal to cooperate will have no untoward effects on their job status. Inasmuch as it is somewhat of an imposition on the worker to take the tests, he should either be allowed to participate on company time or be paid for the time that he contributes in submitting to the tests.

By following the foregoing suggestions it is usually possible to obtain the full cooperation of the workers. It should be realized that failure to get their cooperation during the testing will result in getting an unrepresentative performance from them.

Use of Standardized Procedure in Administration.—A warning should be given that an investigation of validity should never be attempted until the test is in as final a form as can be achieved. It is not desirable to make any changes in procedures after testing has begun, owing to the loss of data such changes always entail. Defects in clarity of instructions should have been detected on small trial groups. Time limits, administrative procedures, and other features should have received empirical justification in the same way. By the time validation testing is begun, all technical procedures should have been smoothed out and demonstrated to be in order.

The administration of the test must follow closely the standardized procedure that has been established. It must be conducted under the same conditions as those which will be encountered when the test is actually put to practical use. This means that both the psychological and the physical environments under which the testees work must be comparable to those environments to be encountered when applicants are tested. If the test when adopted as part of an organization's selective procedure is to be given individually, then it should be given individually to the workers of the validation group and not administered as a group test. If the directions are to be given orally to applicants, then they should be given orally to the worker testees. Unless the directions are to be repeated several times to applicants, they should not be so repeated when testing the workers. Only that type and amount of assistance should be given the worker testees as eventually will be given to the applicant.

The physical environment should duplicate that to be present when the tests are used for practical selective purposes. The tests should not be given in a quiet room or in a room adjacent to roaring machinery, unless such conditions are to prevail when applicants are to be tested. Time of day must be comparable for the two classes of testees. If the tests are to be given to applicants at all hours of the day, then it is not good procedure to test the workers only at certain hours. It is a well-known fact that there are diurnal variations in performance, and therefore the hour of the day for testing should be the same for the two classes of testees. Other factors to be controlled are the ventilation and lighting of the testing rooms, the rest pauses inserted during the testing period, and the timing of the tests.

The timing of the tests is an extremely important feature of administration. Obviously in speed tests the number of questions attempted is directly related to the testing time, and therefore the time must be kept constant for all testees if differences in numbers of items correctly done is to reflect differences in ability. When the tests are short, such as 3 to 5 min., the instructions for taking the tests should not be incorporated in the testing time. When the testing time is 15 min. or longer, and the time needed by the testee to read the instructions and learn what he is to do takes but a few seconds, then the instructions can be included within the testing time.

The error tolerance in timing a test varies with the length of the testing time. With very short tests, such as those under 3 min. duration, the errors should be kept less than 5 sec. With tests of 15 min. or more duration, errors up to 10 sec. can be tolerated. Such errors, however, can be eliminated entirely if adequate procedures for timing are established and if the administrator has had some practice with the test on trial groups.

It should be expected that the total time for the tests will be greater for the validation study than for the final practical testing. All tests in the beginning contain a certain amount of deadwood that can be removed after it is discovered by statistical analyses. Similarly with a battery of tests there will be some tests that will show sufficiently low prognostic power that they should be discarded. The testing time required for the validation study will be about twice as long as the time required after the tests have been pruned of their useless parts.

Number of Testees Necessary.—A requirement of the trial group of testees, whether old-established workers or applicants, is that it should be of considerable size. No categorical statement can be made of just how many testees should be utilized, but certain suggestions can be given that may be helpful in forming the trial group. A group of 20 to 30 testees is too small for any validation study. Probably 50 to 60 individuals should be considered a minimum when tests are to be validated singly. If several tests are to be formed into a battery, then even 100 testees is a minimum group, and 200 or more will give more reliable results. When the available groups are small, but the labor turnover is high, it is possible to accumulate cases from several applications of the test.

Even when a sizable group is available, there will be reductions occurring from several causes. Some reduction will result from the fact that criterion measures will be incomplete and unusable. When using workers, some members of the group may be absent from the testing owing to illness or other causes. A further reduction will result from erroneous test records due to misunderstanding of the directions. The experience gained from validation studies indicates that the number completing an experimental study for whom there will be usable criterion and test scores will be from two-thirds to three-fourths of the number originally available. Knowing this, the test constructor had best seek a group of larger number than that which eventually will be needed to supply data for the statistical analyses.

ANALYSIS OF TEST RESULTS

The determination of the predictive effectiveness of a test can be made whenever there are complete sets of scores on the testees for both the test and the criterion. Various techniques are available for analyzing the data in order to find answers to questions concerning scoring, reliability, validity, and difficulty of individual tests or of a composite battery of several tests. From the analysis, decisions can be made as to which tests are sufficiently valid to be retained, which can be revamped and made useful, and which show such poor promise as to be discarded.

When several tests are being evaluated, the usual finding is that a substantial proportion of the tests will not show satisfactory predictive power. This result has occurred so consistently in psychological testing that it has given rise to the general principle that one should start the validation with two or three times more tests than are desired in the final battery.

The individual items of a test likewise should undergo an empirical evaluation. Not all the items within a test are equally good, and some technique is needed by means of which the less discriminative items can be identified and eliminated. Several statistical procedures have been devised for this purpose.[1] By removing nondiscriminating items it is sometimes possible to salvage a test that because of deadwood does not show satisfactory predictive efficiency on the first tryout. Likewise, satisfactory tests may be further improved, as well as shortened, by the removal of nondiscriminating items. The foregoing facts point up the need of starting the validation with two or three times more items than are desired in the final test.

Of course, the ultimate criterion for deciding whether a test, or which tests of a battery, can be utilized for practical predictive purposes is whether or not the use of the test or tests shows promise of being more effective than procedures already in use. There are many different techniques available for making the desired analysis, which vary in precision and are designed to accomplish the analysis with data expressed in different types of measures. In the following topics it is the intention to give brief descriptions of certain representative techniques having wide usage. For a more complete explanation of the methods treated or for descriptions of other methods the reader is referred to standard texts on the principles of psychological testing.

SCORING THE TESTS

Objectivity of Scoring.—The principal objective in scoring is to attain uniform and accurate evaluation of performance. Methods should be used which enable high-grade clerical assistants to accomplish the work without error and which enable different individuals scoring the same test paper to arrive at exactly the same score. Many different types of keys and stencils have been designed for reducing the scoring to a mechanical procedure, thus effecting a great saving in time without any sacrifice of accuracy. If the test items have been so arranged that all the spaces for recording the answers form a column down the side of the page, then a key with the correct answers can be laid beside the testee's responses, and the number of errors detected in a matter of only a few seconds.

The Scoring Formula.—The scoring formula that will give the highest reliability and validity must be determined statistically. For a time-limited test the scores to be obtained are the number of correct responses and the number of error responses. These are usually referred to as the number of rights and the number of wrongs, respectively. Several different formulas have been devised for combining the wrongs with the rights in order to obtain a single comprehensive score of the performance.[2] Any one of these formulas is to be preferred to an arbitrary method of penalizing the testee one or two points for each error he makes. The logic for penalizing the testee for guessing should not be adhered to strictly, since the object of scoring the wrongs is not to punish the testee for making errors but rather to utilize the wrongs in such a way as to increase the predictive effectiveness of the test. When viewed in this light, it is apparent that errors will not necessarily have the same significance in all tests, and the optimal weighting to be given errors should be worked out for each test by appropriate statistical analyses. It frequently turns out that errors can be wholly ignored in arriving at that measure of performance giving the highest predictive efficiency.

DETERMINING THE VALIDITY OF TESTS

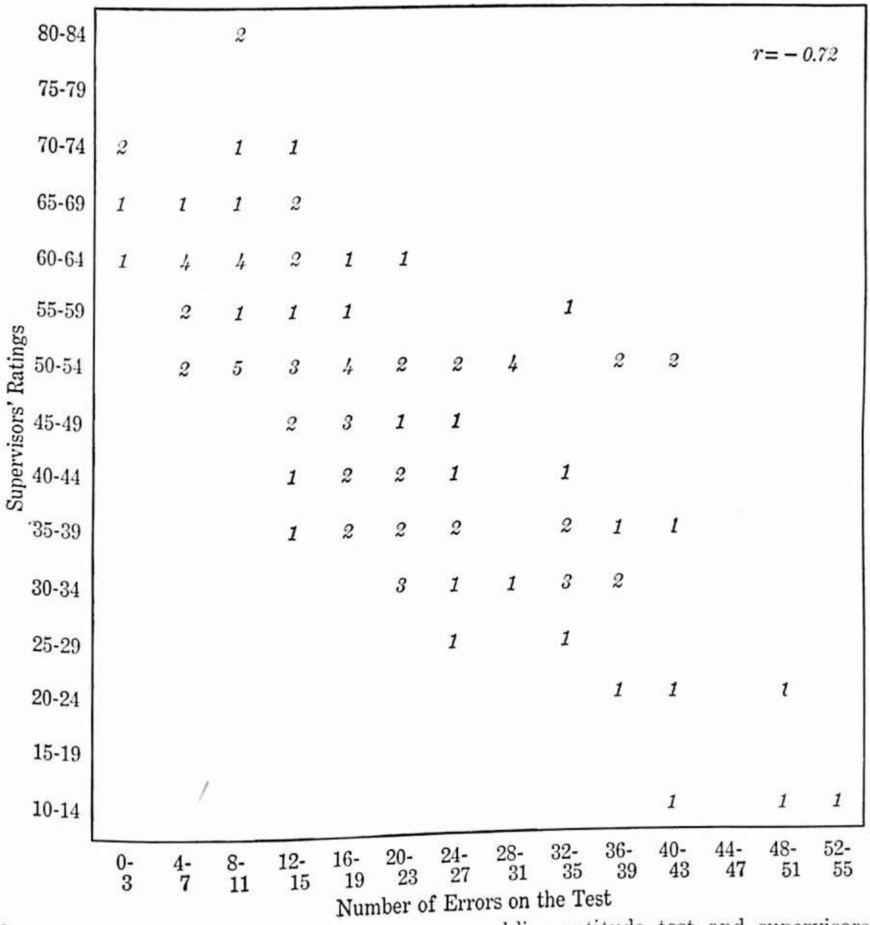
Validation Using Noncontinuously Scored Criteria.—It is not always possible to obtain measures of the criterion in the form of a continuous series of scores, in which various levels of proficiency in job performance are represented as numbers varying in size from low to high with increasing amounts of ability. In lieu of such a refined scale of measures it may be possible to classify the workers with respect to their proficiency into several large groups such as excellent, good, average, and poor or into job classifications such as master, journeyman, and apprentice. A measurement of the test's validity can then be determined by calculating the average test score for each of the groups. For example, in a trade test for asbestos workers, Stead and Shartle found the following average scores for groups of workers differing in skill: experts, 14; apprentices and helpers, 6; related workers, 1.[3]

Another technique involves the computation of the percentage of successful workers scoring above or below various critical scores on the test. On the basis of their job proficiency the workers are classified into two categories as successful and unsuccessful, or as above average and below average. Certain score levels in the test are arbitrarily chosen, and the percentage in the successful group scoring at and above each level is determined. Suppose, for example, that in a group of 200 workers half were classified as satisfactory. It might be found that of those who obtain scores of 10 or higher 60 per cent are satisfactory, of those who obtain scores of 20 or higher 70 per cent are satisfactory, of those who obtain scores of 30 or higher 80 per cent are satisfactory, and so on. As the score level increases, of those making higher scores an increasing proportion are found satisfactory, showing that there is a positive relation between the test score and the probability of being classified as a successful worker. This method is particularly serviceable when it is desired to find a critical score below which the chances of success are sufficiently low that applicants getting that score or less can be rejected without eliminating many workers who ultimately could succeed on the job.

Validation Using Continuously Scored Criteria.—When performance on the job is obtained in the form of a continuous series of scores the best method of determining the validity is the correlation method. The coefficient of correlation measures the closeness of relationship between the criterion score and the test score. It is obvious that the association between the two sets of scores may vary in degree from a zero relation to a perfect, one-to-one, relation. Stated another way, the relationship between the test and the criterion might be so low that no information is gained about a person's performance on the job from knowing his test score. This would be indicated by a coefficient of zero. On the other hand the two series of scores may be so closely related that a person's test score would tell exactly what his proficiency on the job is. In this instance the coefficient of correlation would have the value of 1.00. As the degree of relationship varies between these two extremes of no relation and perfect relation, the coefficient of correlation varies by successive values from 0.00 to 1.00. The coefficient of correlation when used as a measure of the degree of relationship between a testing device and its criterion is called a coefficient of validity.

In Fig. 19 is shown an example of the relationship between scores on a test and a measure of proficiency. The scores are those of 100 welders on a welding-aptitude test, and the criterion is the supervisor's ratings.[4] The coefficient of correlation between test scores and ratings is -0.72. It will be observed that, in general, those workers making good scores were given high ratings, whereas the reverse is true for those making poor scores. The relationship between test scores and ratings is not perfect, but the trend is unmistakable.

Interpretation of the Validity Coefficient.—The question arises concerning the size of the coefficient to be accepted as indicating satisfactory test validity. No particular value or even range of values can be categorically given as being minimal values for an acceptable validity coefficient. If the problem is one of selecting men on the basis of their aptitude or proficiency, the size of the validity coefficient that will indicate that the test is serviceable will depend on the selection ratio.[5] The selection ratio is the ratio of the number of applicants to be selected to the total number of applicants available. When the ratio is small, *i.e.*, when only a small proportion of the applicants will be hired, then all that are hired can be taken from among those of very



Supervisors' Ratings	0-3	4-7	8-11	12-15	16-19	20-23	24-27	28-31	32-35	36-39	40-43	44-47	48-51	52-55
80-84			2											
75-79														
70-74	2		1	1										
65-69	1	1	1	2										
60-64	1	4	4	2	1	1								
55-59		2	1	1	1				1					
50-54		2	5	3	4	2	2	4		2	2			
45-49				2	3	1	1							
40-44				1	2	2	1		1					
35-39				1	2	2	2		2	1	1			
30-34						3	1	1	3	2				
25-29							1		1					
20-24										1	1		1	
15-19														
10-14											1		1	1

FIG. 19.—Relationship between scores on a welding-aptitude test and supervisors' ratings of proficiency of 100 welders.

high scores—the cream of the testees—and there will be no need for selecting any from among those of average ability or lower. When the selection ratio is high, *i.e.*, when most of the applicants must be hired, there can be very little selection actually accomplished, and even applicants of mediocre ability must be hired. The predictive power of a validity coefficient is a function of the size of the selection ratio, the prognostic value decreasing as the selection ratio increases. It follows then that, in order to attain a given standard of predictive power, a higher validity coefficient will be needed when the majority of applicants must be hired than when only the top-scoring testees need be given consideration for the job.

The graph presented in Fig. 20 shows the effectiveness of tests in relation to the validity coefficient and the percentage of applicants selected. From this graph it will be observed, for example, that, with a test having a validity of 0.60, if the 25 per cent of applicants making the highest test scores are selected, 81 per cent of them may be expected to be above average on the job. However, if the test has a validity of 0.30, and the same proportion is selected on the basis of test scores, then only 65 per cent may be expected to be above average on the job.

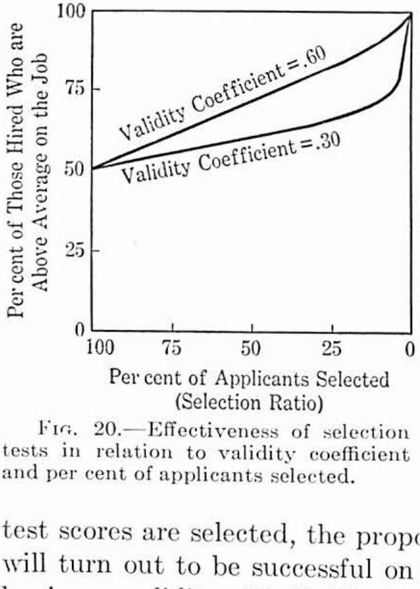


FIG. 20.—Effectiveness of selection tests in relation to validity coefficient and per cent of applicants selected.

Again, referring to Fig. 20, as the selection ratio decreases, *i.e.*, as applicants with higher and higher test scores are selected, the proportion of workers that is selected who will turn out to be successful on the job increases. Thus with a test having a validity of 0.60, if 75 per cent of the workers are selected, 60 per cent of them may be expected to be satisfactory on the job; but if only 25 per cent are selected, 81 per cent of them may be expected to be above average on the job.

When a given proportion of persons are to be selected on the basis of test scores, tests whose scores are more highly correlated with proficiency on the job will select a higher proportion of successful workers. However, under certain circumstances a test with lower validity will bring about better results than a test with higher validity. For example, if a test with a validity of 0.60 is used, and the 75 per cent of applicants making the highest scores are selected, 60 per cent of them may be expected to be above average on the job; whereas if a test has a validity of only 0.30, and the 5 per cent of applicants making the highest scores are selected, 74 per cent of them may be expected to be above average on the job. In this case better results are obtained with the test having the lower validity because it is being put to more effective use. In this sense, then, a low selection ratio may be said to be a substitute for high validity.

Past practice should dictate any statements relative to the minimal values of validity coefficient that are usable. For single tests the lower limit of usable coefficients is in the neighborhood of 0.35 to 0.40. For tests to be included in a battery the lower limit is in the neighborhood of 0.20 to 0.25. In formulating the latter statement it is assumed that the correlations between the tests to be combined are not high, being in the neighborhood of 0.40 or less. These values are to be considered only as rough estimates based upon the results of the application of tests in a large number of practical situations.

Weighting Tests in a Battery.—When several tests are available the problem arises of choosing that combination and number which will give the highest prognostic power. Although the validity of a single test is a direct function of the closeness of the relationship between the test and the criterion, the validity of a battery of tests is a function of both the relationship between each of the separate tests and the criterion and the closeness of relationship between each test and every other test. In general it can be said that the correlation between the tests and the criterion should be as high as possible, and the correlation between pairs of tests as low as possible. In constructing a battery of tests one encounters the law of diminishing returns in making additions to the battery, so that the point is reached when the addition of another test does not pay sufficient dividends in prognostic value for the additional work it entails. Again there are statistical methods available for selecting from among several tests that particular number and combination which will give the maximum practical validity.[6]

DETERMINING THE RELIABILITY OF TESTS

The Reliability Coefficient.—A quantitative estimate of reliability is obtained by the use of some form of the coefficient of correlation. The assumption is made that if the individual testees in a group retain their same relative positions when measured twice by the same device, then that device is reliable. The coefficient of correlation between the two measurements is called the *coefficient of reliability* and is interpreted in the same manner as any other correlation coefficient. If the individual cases retain exactly the same relative positions in the two measurements there will be a perfect positive correlation between them, and the reliability coefficient will have the value of 1.00. As the two scores for each individual become farther apart in relative position, the reliability decreases until eventually a zero coefficient is obtained, indicating that the two measurements bear no relation to each other.

There are several methods of estimating the reliability of a test. Some depend upon having two tests as nearly alike as possible, others depend upon giving the same test twice to the same group of testees with a period of time between testings, whereas others are based on statistical analyses of the data from one test administered only once. There are advantages and limitations to each of these methods. The method receiving rather wide application in recent studies of test reliability is the method of rational equivalents, which requires only one administration of a single test.

The Size of the Coefficient of Reliability.—As in the case of validity it is important to know how large the reliability coefficient should be in order to consider the test satisfactory. Practical experience again should be relied upon for suggestions. If the test score is to be used for selection or placement purposes, then the minimal value of the coefficient should be in the neighborhood of 0.85 to 0.95. When test results are to be used only for group comparisons, coefficients as low as 0.80 to 0.85 may be used.

There is recent evidence to the effect that tests of low reliability—as measured by the reliability coefficient—may prove very serviceable when used in a battery with other tests. As reported by Guilford, tests were found in the Aviation Psychology Program during the last war that had consistently good validity in spite of reliability coefficients of 0.35 to 0.40.[7]

ITEM ANALYSIS OF TEST RESULTS

Item Validity.—Study of the individual items of a test is important because the effectiveness of the total test is a function of the effectiveness of the items. If a criterion measure of job success is obtained, it is possible to determine the prognostic power of each item by comparing the answers on the item with the scores on the criterion. If most of the workers who correctly answer an item get high criterion scores, and most of the workers who fail the item get low criterion scores, then the item has a very high prognostic value. An item that could be passed by individuals from all levels of job proficiency obviously would not be a discriminating item.

There are many statistical techniques available for getting a quantitative estimate of the predictive effectiveness of individual items; the choice between them is dependent upon the form of the data, the accuracy demanded, the time available for computation, and other similar factors. After the predictive value of every item has been determined, it is then possible to identify those items which have low validity and discard them, and to select from the remaining ones those which have the highest prognostic value, thus improving the validity of the total test.

Item Reliability.—As a general rule, the reliability of the individual items is not computed but merely assumed from the reliability of the test as a whole. However, the determination of item reliability may be desirable. The problem of item reliability may be thought of as the degree to which all the items are measuring the same thing. If every item is measuring what every other item is measuring, then they are reliable and the test as a whole is reliable. This characteristic also is referred to as *internal consistency*. It is measured by determining how closely each item agrees with the total test score. The usual technique is to use the total test score as a basis for dividing the testees into a high group and a low group. Then the proportion of each group answering an item correctly is computed. If the proportion of the high group answering it correctly is significantly greater than the proportion of the low group answering it correctly, the item is considered reliable.

If an item analysis is made against a criterion, then the computation of item reliability usually is not necessary. There are statistical methods by means of which both the relation of an item to the criterion and its relation to the other items in the test are taken into consideration in determining the item validity, and these methods are to be preferred to the simpler methods described above.

Item Difficulty.—The percentage of testees who answer an item correctly determines the level of difficulty of that item. Items correctly answered by all testees or not answered correctly by any testees have no discriminating power and therefore should be discarded. Items selected for the final test should vary in difficulty within the range of from 5 per cent to 95 per cent correct answers, with the majority of them having a difficulty in the neighborhood of 50 per cent.

Analysis of Alternative Answers in Multiple-choice Items.—In any multiple-choice type of test the incorrect answers must be constructed with as much care as the correct answers. An incorrect answer used as an alternative, also called a "mislead," must be constructed so as to be attractive, at least to a small percentage of the testees. If in a four-choice item a mislead does not attract any responses, then the item really only has three choices and not four. Such undiscriminating alternatives will affect both the reliability and the validity of the test as a whole. It is important to determine the frequency of response to each mislead so that misleads having zero per cent frequency of responses can be revised or other misleads substituted for them.

REVISION OF A TEST

In the preceding pages the discussion has dealt with certain procedures that can be used for determining the validity and reliability of the test as a whole and of the separate items within the test. Such studies as described above discover the essential facts needed to evaluate the testing program. From them the decision can be made relative to the type of revision that should be made in rejecting, revising, or adding new items to the test or tests. In addition, from the experience of administering the tests to the group of workers much information is obtained about the adequacy of the administrative directions and the correctness of the time limits. In the light of all the information obtained, the tests or battery of tests should be revised in all features shown to be deficient. In the end, methods for administering, timing, and scoring each test are standardized, and a shorter but more valid measuring instrument is achieved. It must be recognized that no test constructor, even though highly skilled as a technician, can produce a valid instrument without taking advantage of such procedures as have been described above.

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CHAPTER VIII

EXAMPLES OF EMPLOYMENT TESTS IN USE

In the present chapter we shall review certain findings concerning the effectiveness of various types of tests used for employment purposes, especially in relation to their prediction of job success. In addition we shall consider certain problems relative to the use of specific tests in the placement of workers. Although psychologists have been reporting on the effectiveness of various employment tests for more than twenty-five years, in only rare instances has any given test been validated for a particular job more than a very few times. Therefore in the following review of tests there will be a disappointingly small number of evaluations for specific tests. For the most part this means that tests of a given type necessarily will have to be grouped together in order to obtain reliable information concerning their usefulness.

One important finding should be noted with respect to the validity of tests. Even when the same test is evaluated in terms of the same kind of criterion for the same type of job, but in different organizations, there will be marked variations in the validity obtained. The factors leading to such discrepancies are many. In some instances, differences in the kind of persons used in the validation studies will account for variation in results. In other cases, differences in the reliability of the criterion or in the manner in which it is determined will be the important consideration. However, in many cases the causes of variation in the validation results will not be apparent. This means, therefore, that even though a test has been found to be useful in predicting success in a given job in one organization there is no guaranty that it will be equally useful in predicting success in that same type of job in another organization.[1]

In the following pages the usefulness of tests for the various occupational groups will be considered. In addition, special attention will be given to intelligence tests, first of all because they are so widely used, and secondly because more is known about them than any other type of test.

TESTS FOR SEMISKILLED WORKERS

The tests found most useful in the selection of semiskilled workers are measures of the more or less simpler psychological functions, such as manual dexterity and motor ability, ability to perceive details, eye-hand coordination, and ability to perceive spatial relations. Some of these tests will be described, and typical studies in which they have been found useful will be mentioned. It should be noted that not all these tests will be found useful for the selection of employees for any given semiskilled job. Quite the contrary, because for a given job most of the tests will not adequately differentiate the better from the poorer workers. The scores yielded by any one of these tests will bear little relation to the scores yielded by any other, thereby indicating that they are measuring rather different abilities. Only when the abilities and skills measured by the test are similar to those involved on the given job can the test be expected to have reasonable validity.

Tests of Manual Dexterity and Motor Ability.—Tests of this sort may be classified into two types, those measuring ability to manipulate the arm together with manual dexterity of a rather gross kind, and those involving primarily finger and hand movements alone. Perhaps the most widely used test of gross arm-hand dexterity is the Minnesota Placing Test. This test consists of a board in which there are 58 round holes about 1¾ in. in diameter arranged in four rows. The subject is required to pick up and place cylindrical blocks in these holes, while the examiner notes the time required to put all the blocks in the holes.[2] Norms for the general population are available for this test. Other tests of this type are the block-packing test, wherein the individual packs wooden cubes into a box, and the pegboard test, wherein pegs about ½ in. in diameter and 2 in. long are inserted into holes of appropriate size.

Three tests designed primarily to measure hand and finger dexterity, with little or no arm movement, are the Minnesota Turning Test[3] and the O'Connor Finger and Tweezer Dexterity Tests.[4] The same board and blocks are used for the Minnesota Turning Test as for the Minnesota Placing Test. In the Turning Test the blocks are already placed in the holes, and the subject is required to turn over every block as quickly as he can, the score being the time required to complete the task.

The O'Connor Finger Dexterity Test consists of a plate in which there are 100 holes about 3⁄16 in. in diameter arranged in rows ½ in. apart. Into these holes the testee inserts pins 1 in. long and about 1⁄16 in. in diameter. With one hand he picks up three pins at a time and inserts them in one hole. The score is the time required to fill all the holes in this manner. The O'Connor Tweezer Dexterity Test is similar to the Finger Dexterity Test except that the subject picks up the pins one at a time by means of a pair of tweezers and inserts them into the holes. Again the subject is scored on the basis of the time it takes him to fill all the holes. Norms for the general population have been reported for these two tests.[5]

Tests of Ability to Perceive Detail.—In many of the semiskilled jobs the work requires that the employee have the ability to perceive small differences in detail. In certain cases, for example, defective items must be detected and removed where the differences between the perfect and defective items are so small that constant attention is necessary. One of the first tests used to measure the ability to perceive details is the cancellation test. The test consists of rows of letters (or numbers) arranged in haphazard order, and the instructions are to cancel all the letters of a given kind, *e.g.*, the *a*'s. Ordinarily the test is administered as a time-limit test, and the subject's score is usually calculated as the number of items correctly cancelled minus the number omitted or cancelled incorrectly. The number-finding test is similar to the cancellation test; the numbers are scattered at random over the page and the subject is instructed to discover and encircle all instances of a given number.

It is interesting to note that a test designed to measure success in clerical work and involving ability to perceive detail has been found to be successful in the selection of semiskilled workers. This paper-and-pencil test, the Minnesota Clerical Test, consists of two parts, a number-checking test and a name-checking test.[6] A series of pairs of numbers or pairs of names is presented to the subject, and he is required to check the pairs that are the same and leave blank the pairs that are different. The subject is scored in terms of the number of correct items completed in a given amount of time, 8 min. being given for the number checking, and 7 min. for the name checking. This test has norms for the total employed population,[7] and the performance on it of a number of different occupational groups has also been reported.[8]

Tests of Eye-hand Coordination.—Obviously most of the tests described as tests of manual dexterity and motor ability involve eye-hand coordination to a considerable degree. There are, however, a number of tests involving eye-hand coordination in which the factor of manual dexterity is distinctly at a minimum. MacQuarrie has developed two paper-and-pencil time-limit tests of this type that have been found to be very useful.[9] The first, the dotting test, consists of a series of small circles about $\frac{3}{16}$ in. in diameter, into each of which the subject is to make a single dot by means of a pencil. The tracing test is made up of a series of printed squares connected, one to another, by parallel lines separated by about 1/16 in. The subject, keeping his pencil in constant contact with the paper, moves it as rapidly as he can from one square to the next, endeavoring to pass between the parallel lines without touching either line.

Various other tests of ability to follow a path have been developed, such as paper-and-pencil maze tests. One other test of eye-hand coordination, which involves somewhat greater use of the hands and arms, is the card-sorting test. Two or more decks of common playing cards are shuffled together, and the subject is required to sort them into boxes according to suit, time and errors being noted.

Tests of Ability to Perceive Spatial Relations.—The earliest developed tests of the ability to perceive spatial relations were performance tests, in which the testee is provided with a series of irregularly shaped pieces which he is to fit into appropriately cut holes in a board. The score on such tests is the time taken to fit the pieces correctly into the board. The best of these tests that has been standardized for industrial purposes is the Minnesota Spatial Relations Test.[10]

A paper-and-pencil test of the ability to perceive spatial relations, the Minnesota Paper Form Board Test, has been developed by Lickert and Quasha.[11] In this test each item consists of a series of complexly shaped geometric figures—which are divided by lines into smaller parts—and a standard figure, whose parts exactly match or fit into one of the members of the series of geometric figures. The testee selects the figure in the series which matches the standard figure. The score in this case is the number of figures correctly identified in a given amount of time. The MacQuarrie block test is a paper-and-pencil test in which a series of groups or piles of blocks, depicted in three dimensions, is presented.[12] For each pile the subject is required to tell how many of the blocks touch on a certain specified block. Paper-and-pencil maze tests sometimes are found useful in the measurement of ability to perceive spatial relations.

Examples of the Use of Tests in the Selection of Semiskilled Workers.—One of the earliest studies made in this country relative to the use of tests in the selection of semiskilled workers was made by Link.[13] He studied the usefulness of several tests in a munitions plant. The coefficients of correlation were obtained between the scores made on each of three tests by a group of 52 shell inspectors and the number of pounds of shells they inspected per hour for a 4-week period. For a card-sorting test the validity coefficient was found to be 0.55, for a cancellation test 0.63, and for a number-checking test 0.73.

Each of these tests adequately differentiated superior from inferior workers, and a combination of them undoubtedly would have given a better prediction of job success than any one used singly.

Treat reports an interesting investigation of tests for garment-machine operators.[14] A group of 101 subnormal girls with IQ's ranging from 40 to 70 were rated for ability to run electric sewing machines, and the correlations were obtained between these ratings and the following tests: a trimming test that involved cutting out a design between a path of double lines, the path becoming narrower as it progressed; a paper-and-pencil maze test; a paper-folding test that involved the folding of a small piece of paper in designated ways; a card-sorting test; and a manual-dexterity test that involved the insertion of a stylus into each of three holes in rotation. The validity coefficients of each of these tests are shown in Table 41. A weighted combination of the scores yielded a validity for the battery of tests of 0.66.

TABLE 41.—COEFFICIENTS OF CORRELATION BETWEEN SCORES MADE ON SEVERAL TESTS BY GIRLS OPERATING GARMENT MACHINES AND RATINGS OF JOB SUCCESS

Test	Validity Coefficient
Pencil-and-paper maze	0.58
Trimming	0.53
Paper folding	0.52
Card sorting	0.35
Scott dexterity	0.21

In a study of the selection of women for various simple assembly jobs at the Western Electric Company, Hayes used both a pegboard test and the O'Connor Finger Dexterity Test.[15] Each of these tests was found to differentiate the better from the poorer workers. For example, scores on the pegboard test were found to correlate 0.31 with ratings of job success, and 0.37 with output records.

The investigators associated with the U.S. Employment Service administered a variety of tests to workers in several different semiskilled jobs and obtained the correlations between scores on these tests and measures of job success.[16] Some of the more significant relationships which were found are shown in Table 42. These results illustrate the utility of tests of simple functions, such as manual dexterity and motor ability, ability to perceive spatial relations, ability to note detail, and eye-hand coordination, in the selection of employees for semiskilled work.

TABLE 42.—EXAMPLES OF THE VALIDITY OF TESTS IN THE SELECTION OF WORKERS IN CERTAIN SKILLED JOBS

Can packer; $N = 43$; criterion = work-sample test

0.45	Pegboard
0.35	Ziegler placing
0.28	Minnesota Paper Form Board
0.25	Minnesota Spatial Relations
0.26	O'Connor Finger Dexterity

Inspector-wrapper; $N = 41$; criterion = ratings

0.30	Minnesota Name Checking
0.27	Number finding

Merchandise packer; $N = 30$; criterion = production

0.49	MacQuarrie Dotting
0.45	Minnesota Name Checking

Power-sewing-machine operator; $N = 46$; criterion = production

0.40	Minnesota Number Checking
0.32	MacQuarrie Block Test
0.31	Minnesota Paper Form Board
0.23	Minnesota Name Checking

Put-in-coil girl; $N = 18$; criterion = production

0.57	O'Connor Tweezer Dexterity

There has been very little evaluation of tests for the selection of people for semiskilled work in the service occupations. One of the few systematic attacks is reported by Dvorak.[17] Several tests were administered to janitors who had been rated on the basis of job success. The results, given in Table 43, indicate that for this particular job the intelligence test gives the best differentiation between the better and poorer workers. There is a suggestion of differences between the performance of these two groups on spatial-relations and mechanical-ability tests, but the differences between the average scores of the two

TABLE 43.—SCORES ON SEVERAL TESTS MADE BY JANITORS GROUPED ACCORDING TO EFFICIENCY RATINGS

Test	Average score		Critical ratio of the difference
	Better workers	Poorer workers	
Intelligence	48.7	31.6	5.2
Spatial relations	1,360.9	1,589.1	2.1
Mechanical ability	74.1	66.4	2.1
Tweezer dexterity	382.2	399.6	1.0
Finger dexterity	293.5	290.0	0.2

groups found for the two finger-dexterity tests are insignificantly different from zero.

Summary of the Effectiveness of Various Tests for Semiskilled Workers.—Figure 21 summarizes the validity coefficients of eight types of tests in terms of their effectiveness in predicting the success of workers engaged in assembly and packing occupations. In all cases the criterion of job proficiency is productivity or ratings of productivity. It will be noted that for workers employed in assembly and packing operations the best tests appear to be measures of ability to appreciate spatial relations, finger dexterity, and ability to differentiate details (number and name comparison).

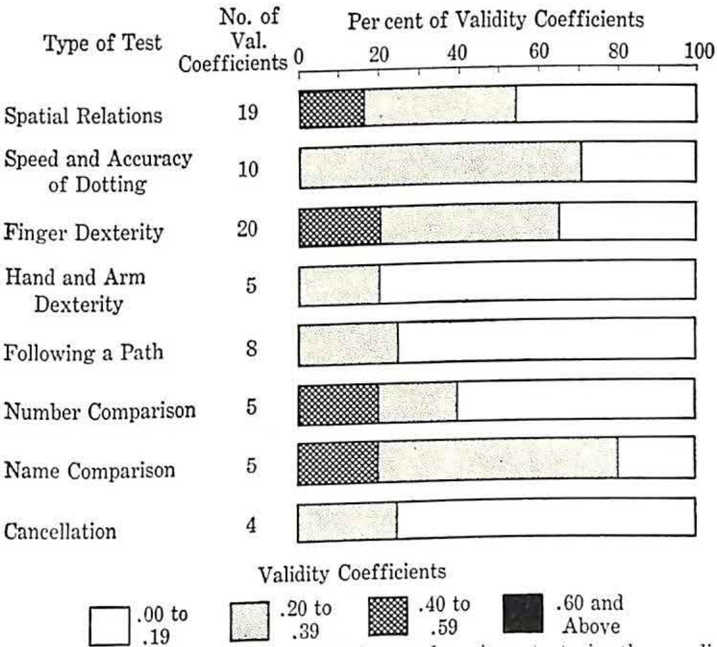

FIG. 21.—Summary of the validity coefficients of various tests in the prediction of productivity of workers engaged in assembly and packing occupations.

An example of an interpretation of the figure follows: In nineteen reported studies of spatial-relations tests for jobs of this sort, none of the validity coefficients was found to be 0.60 or above, 16 per cent were between 0.40 and 0.59, 38 per cent were between 0.20 and 0.39, and 46 per cent were between 0.00 and 0.19. About the same distribution of validity coefficients has been found for finger-dexterity tests. Although the number of reports for number- and name-comparison tests is small, they too appear to have given about the same validation statistics. Contrary to expectation, tests of arm dexterity appear to be rather inadequate.

A summary of the validity coefficients of various tests in the prediction of the productivity of workers engaged in mechanical occupations is given in Fig. 22. Although the number of supporting investigations is small, mechanical-assembly tests, which involve the assembly of small mechanical objects such as bicycle bells, seem to be outstanding. Quite good results have been obtained with spatial-relations tests, number-comparison tests, and measures of finger dexterity. Tests involving the following of a path give fairly good results.

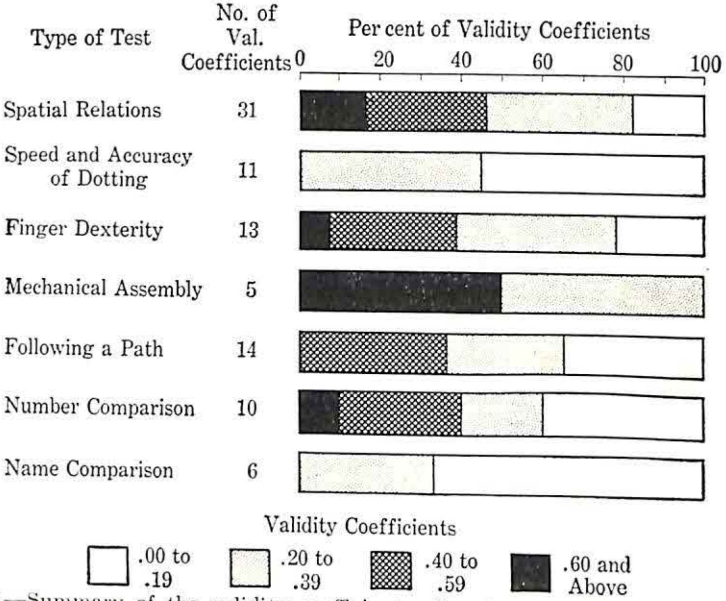

FIG. 22.—Summary of the validity coefficients of various tests in the prediction of productivity of workers engaged in mechanical occupations.

TESTS FOR SKILLED WORKERS

Examples of Tests for Skilled Workers.—For some jobs requiring considerable skill, the nature of the work is of such high specificity that the employer must of necessity provide training for the job. In cases such as these, aptitude rather than proficiency tests are therefore demanded. A typical example is the job of panel-dial switchmen.[18] Applicants for this job must be trained in a special company school before they can start work as switchmen. The training course, involving the study of theory and application of electricity, is of considerable length; hence, any means of preselecting employees on the basis of their probable future success would yield a considerable saving of expense on the part of the company, and a saving of time on the part of those men who could not adequately perform the type of work involved. The battery of tests developed for use in the selection of such employees is given in Table 44, together with their correlations

TABLE 44.—SUBTESTS USED IN THE BATTERY FOR THE SELECTION OF PANEL-DIAL SWITCHMEN AND THEIR CORRELATIONS WITH THE CRITERION MEASURE OF EFFICIENCY RATINGS

Type of Test	Validity Coefficient
Knowledge of electricity	0.40
Knowledge of electricity	0.46
Knowledge of electricity	0.46
Arithmetic	0.52
Knowledge of function and adjustment of apparatus	0.35
Knowledge of function and adjustment of apparatus	0.49
Paper-and-pencil maze (to measure ability to trace circuits)	0.42
Paper-and-pencil maze	0.23
Paper-and-pencil maze	0.26

with efficiency ratings made by superiors. A weighted combination of the tests yielded a correlation of 0.68 between the battery of tests and the criterion.

Shartle set up tests for the selection of trouble men for the Milwaukee Electric Railway and Light Company.[19] The job involved repairing underground and overhead lines, substation switching, and minor repairing on cutomers' premises. The work therefore ranged from the replacing of simple fuses to the handling of lines carrying upward of 5,000 volts. Each of 27 trouble men was rated for job success by two superiors, the correlation between the two sets of ratings being 0.87. A correlation of 0.67 with this criterion was yielded by a composite of the following paper-and-pencil tests: a pursuit test involving the ability to follow interwinding lines and to straighten out complicated tangles, a block test similar to the MacQuarrie test, an arithmetic test, a circuit-tracing test, and two tests concerning the characteristics and application of electricity. When the men were divided into those who were involved in accidents the year before and those who were not, it was found that the average score on the battery of tests made by the first group was 85, whereas that of the second group was 96.

Selection of Apprentices.—Since in many cases in industry, boys and young men are selected for apprentice training in certain skilled occupations, a number of investigations have been made relative to the use of tests in the selection of the most likely candidates for such training. Two examples of such tests may be described. In the Scovill Manufacturing Company, Pond reports results obtained from 320 toolmaker apprentices who were rated on job success by their foremen at the beginning of their training period and again 1 year after training.[20] By the time the second set of ratings was made, a number of apprentices had been dropped as unsatisfactory. In comparing the ratings of 155 boys who had been selected on the basis of having made a high score on the Army Beta test—a nonlanguage intelligence test—with the ratings of 165 boys who had not been tested, it was found that on the first ratings 83 per cent of the tested group were considered satisfactory, whereas only 61 per cent of the non-tested group were so considered. On the second set of ratings the percentages considered satisfactory were 97 and 82 for the tested and non-tested groups, respectively. An investigation of the selection of pressman apprentices has been made by Hall.[21] Three instructors rated 89 apprentices according to their job success, and a correlation of 0.58 was obtained between this criterion and scores on the Minnesota Paper Form Board Test.

The Use of Proficiency Tests.—In many if not most cases where skilled workers are to be selected, only individuals who have completed training for the particular job or who have previous experience on similar jobs are considered as applicants. With the exception of trade tests or other measures of proficiency, and aptitude tests for highly specific job skills as already illustrated, tests will not play a highly significant role in the selection of skilled workers. In place of tests, evidence of proficiency can be demonstrated by other means, such as union membership, certificates of competency, licenses to practice, etc.

TESTS FOR SALESPERSONS

Intellectual versus Personality and Interests Tests.—Practically all the investigations that have been made concerning the selection of salespersons by means of tests have dealt with either department-store salespersons or life insurance salesmen. The results obtained from the studies of these two very different jobs agree in one major respect, viz, that measures of personality and interest give the best prediction of job success, whereas tests designed to measure intellectual ability of one kind or another have very little value. This may be seen in results obtained by the U.S. Employment Service which are given in Table 45.[22] It will be observed in this table that none of the tests, except those dealing with personality and interest, has adequate validity. The final measure on the list, personal data, which includes such personal history items as education, age, etc., and gives a rough description of the individual's personality, has a higher validity than any of the measures of ability. These findings bear out Anderson's conclusions, based on a psychiatric study of salespersons in Macy's department store, that personality factors are the most important ones conditioning sales success.[23]

TABLE 45.—THE VALIDITY OF SEVERAL TESTS AS MEASURES OF SUCCESS IN DEPARTMENT-STORE SELLING AS DEMONSTRATED BY THEIR EFFICACY WITH THREE DIFFERENT GROUPS OF DEPARTMENT-STORE SALESPERSONS

Test	Validity coefficients		
	109 salespersons	153 salespersons	235 salespersons
Sentence completion	−0.18	−0.09	−0.11
Number comparison	−0.17	−0.12	
Name comparison	−0.16	−0.14	
Number writing	−0.10	−0.07	
Vocabulary	−0.10	−0.01	−0.17
Arithmetic	−0.12	−0.12	
Number finding	−0.05	−0.14	−0.05
Interest	0.34	0.37	0.44
Personality	0.35	0.32	0.34
Personal data	0.29	0.19	0.23

A summary of the validity coefficients of tests of various intellectual abilities and of various measures of interests and personality in predicting the productivity of salesmen is given in Fig. 23. Whereas validity coefficients of 0.20 or higher were obtained in only 23 per cent of the reports using tests of intellectual ability, such coefficients were found in 88 per cent of reports using interest and personality measures.

Important Personality Traits and Interests.—From a variety of studies of sales personnel, it would appear that the successful department-store salesperson is characterized by social aggressiveness, extraversion, and emotional stability.[24] However, knowing the important traits is one thing, and measuring them in an employment situation is quite another. A number of personality measures covering a wide variety of different traits have been developed.[25] Most of the measures of personality that can be utilized in the ordinary employment stituation are questionnaires. The limitations of this method in the hiring of new employees has already been considered. Suffice it to say that the outstanding success of personality inventories as illustrated in Fig. 23 occurs only when the workers are tested under highly favorable conditions and when they are willing to give honest answers.

The inadequacies of the personality inventory method either are completely avoided or are reduced to a very large extent in the Strong Vocational Interest Blank. As has been pointed out, this test is designed to measure how closely an individual's interests coincide with those of people who are successful in given occupations.[26] Although this test was not designed to predict the productivity of salesmen, it has been found to serve this function rather well with certain groups of salesmen. In Table 46 are given data obtained by Strong showing the relationship between the interest scores in life insurance selling and the average yearly sales of 181 life insurance salesmen.[27] It will be

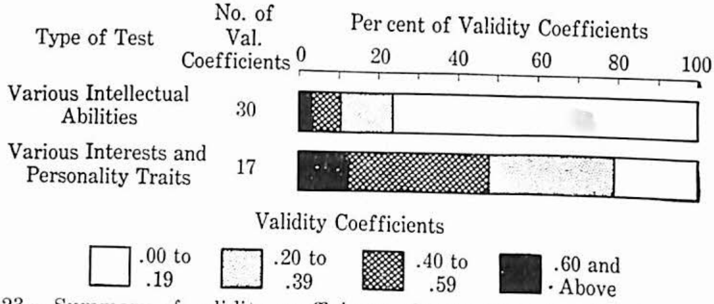

FIG. 23.—Summary of validity coefficients of tests of various intellectual abilities and tests of various interests and personality traits in the prediction of success of salesmen.

TABLE 46.—THE RELATIONSHIP BETWEEN INTEREST IN LIFE INSURANCE SELLING, AS MEASURED BY THE STRONG VOCATIONAL INTEREST BLANK, AND THE AVERAGE YEARLY SALES OF 181 LIFE INSURANCE SALESMEN

Number of salesmen	Test score	Average yearly sales
105	A	$191,000
38	B+	145,000
17	B	133,000
5	B−	136,000
16	C	72,000

noted that there is a regular and marked increase in amount of sales associated with increasing strength of interest.

Bills reports that a combination of interest ratings on the Strong blank for Life Insurance Salesman and Real Estate Salesman gives a good prediction of the success of casualty insurance salesmen.[28] Ghiselli, in the case of casualty insurance salesmen, found validity coefficients of 0.38 and 0.27 for the Strong scales for certified public accountant and occupational level, respectively.[29] As yet the Strong test has been standardized only for two sales jobs, life insurance salesman and real estate salesman. However, since different interests tests have been found to be effective in the prediction of success in other types of sales jobs (Table 45), measures of interests would seem to be one of the most promising types of test for use in the selection of salesmen.

TESTS FOR CLERICAL WORKERS

Since a large proportion of the employed population is engaged in office work of some sort, tests that may be used in the selection of employees for such work will be of considerable importance. The nature of the work involved in the various clerical occupations shows marked differences from job to job, ranging from the relatively unskilled work of office and messenger boys to the highly responsible supervisory positions, preparation for which may require many years of experience and training. Consequently it is necessary to consider office work as a group of related jobs or as an occupation.

The Minnesota Vocational Test for Clerical Workers.—The Minnesota Vocational Test for Clerical Workers, which has already been described, resulted from an attempt to develop a test for measuring success not only in specific office jobs but also in the general occupation of clerical work.[30] Since so much is known about this test, and its usefulness has been so well demonstrated, it deserves special consideration. The investigations that have been made with this test indicate that it is a valid measure of success on many jobs of a clerical nature. The validity coefficients of this test range from 0.28 to 0.66, with an average of about 0.50. Inasmuch as scores on the number-checking part of the test have been found to be related to arithmetic ability and to scores on the name-checking part, it may be said that with office workers the test measures more than the mere ability to notice detail.

Another important characteristic of the test is that the scores differentiate various grades of office workers. In Table 47 it will be seen that, in general, employees on the more complex clerical jobs make better scores than employees on the less complex jobs. This means that the test can be used to predict not only how good an individual will be on a specific office job but also his potentialities for later promotion.

TABLE 47.—AVERAGE SCORES OF VARIOUS CLASSES OF CLERICAL WORKERS ON THE MINNESOTA CLERICAL TEST

Occupational group	Number checking	Name checking
Women:		
Office-machine operators	149	134
Typists and stenographers	147	158
General clerical workers	139	147
Routine clerical workers	133	134
Men:		
Accountants and bookkeepers	144	127
Bank tellers	137	134
General clerical workers	134	131
Routine clerical workers	133	118

One interesting and important characteristic of the Minnesota Clerical Test is that the scores are relatively independent of age, the correlation between age and test scores being −0.19. The findings indicate that there is no change in test score until age 40, but beyond this age there is a slight decrease in score. It seems likely that this reduction may not be due to age, however, but may be attributed to a selection of cases in the samples studied, the better clerks having moved up to higher positions as they grew older.

Coefficients of correlation of 0.08, 0.30, and −0.19 have been reported between amount of experience and test scores. These correlations seem to vary in an unsystematic fashion from zero, and, although the evidence is not statistically sufficient, it would appear that there is little or no relationship between test score and amount of experience. If this finding is true, the test must be considered primarily an aptitude test rather than an achievement test.

Tests for Typists and Stenographers.—Since neither private nor public offices attempt the training of typists and stenographers, achievement rather than aptitude tests are used for the selection of people for these jobs. Typically, a work-sample test is used. For the selection of typists, the test involves the typing of unfamiliar material for a specified time, say 10 min., the number of words typed during this time and the number of errors made being noted. For the selection of stenographers, in addition to the typing test, a dictation test is given in which material, dictated at varying rates of speed, is recorded in shorthand and later transcribed by the applicant. As examples of the dependability of these tests, the typing test used by the U.S. Employment Service was found to have a reliability of 0.96, and the dictation test 0.84.[31]

The work carried on by typists and stenographers is not solely the recording and transcribing of dictated notes. Usually there are other tasks varying in complexity that these workers are required to perform. It is not surprising, therefore, that the Minnesota Clerical test shows a correlation with the job proficiency ratings of typists and stenog-

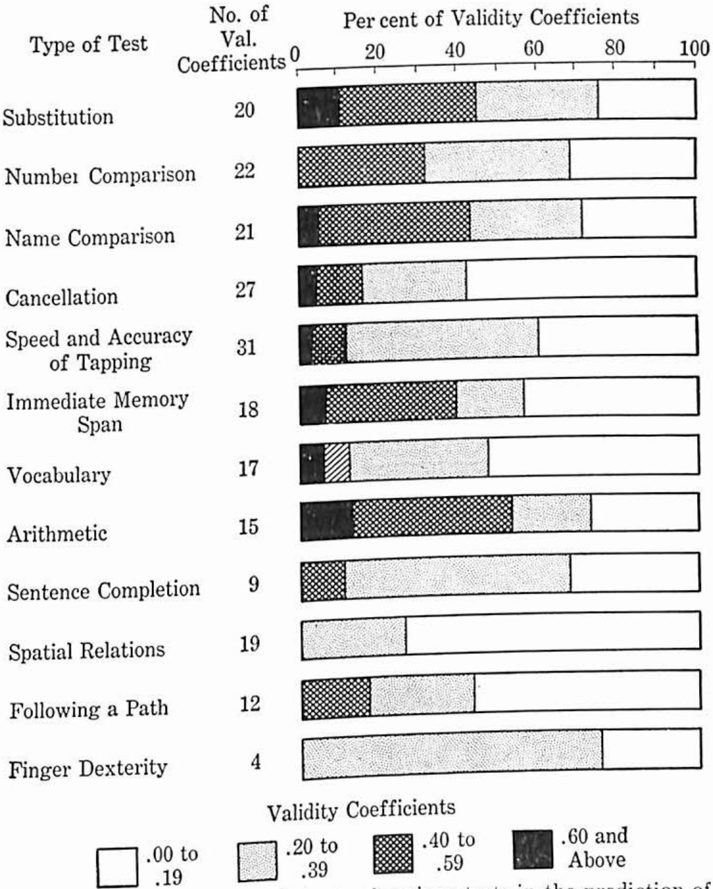

FIG. 24.—Summary of validity coefficients of various tests in the prediction of productivity of workers engaged in clerical occupations

raphers.[32] Link used spelling and grammar tests and tests similar in content to intelligence tests, and found a correlation of 0.73 between a combination of these tests and the efficiency ratings of 24 stenographers.[33] O'Rourke also used a test battery with items similar to those found in intelligence tests, such as problems involving practical judgment, vocabulary, English usage, spelling, and reading comprehension, and found correlations between scores on this battery and efficiency ratings of 0.71 and 0.76.[34]

Summary of the Effectiveness of Various Tests for Clerical Workers.—Figure 24 presents a summary of the validity coefficients of various tests used in predicting the productivity of workers engaged in clerical occupations. It will be observed from this figure that a number of different types of tests have proved useful. Outstanding among these appear to be tests of intellectual abilities such as vocabulary, arithmetic, and sentence completion; tests of ability to perceive differences in detail, such as the name- and number-comparison tests and cancellation tests; measures of immediate memory span; substitution tests; and tests of ability to make rapid and accurate movements.

TESTS IN THE PROTECTIVE SERVICE

Very little work has been done in validating tests for the selection of employees in the protective-service occupation. One investigation will be described here because of the variety of tests that was employed. Diehl and Paterson obtained ratings on the job proficiency

TABLE 48.—PERCENTAGE OF THE GENERAL EMPLOYED POPULATION EXCEEDED ON SEVERAL TESTS BY POLICEMEN OF VARIOUS DEGREES OF JOB SUCCESS

Test	Job ratings		
	Inferior	Average	Superior
Intelligence	39	41	71
Number comparison	50	57	68
Name comparison	42	50	72
Finger dexterity	33	46	46
Tweezer dexterity	17	36	39
Mechanical ability	44	58	61
Spatial relations	15	32	30
Emotional stability	65	74	75
Self-sufficiency	52	54	67
Extroversion	69	75	74
Dominance	61	71	75

of 124 policemen to whom the following tests were administered: the Pressey Classification and Verification (intelligence) tests, the Minnesota Clerical, Mechanical Assembly, and Spatial Relations tests, the O'Connor Finger and Tweezer Dexterity tests, and the Bernreuter Personality Inventory.[35] The policemen were classified on the basis of their job ratings as superior, average, and inferior. The average of the scores of each of these groups on the various tests is shown in Table 48. It is significant to note that all the tests used differentiate the superior from the inferior policemen. The intelligence and the name-checking tests appear to give the best differentiation.

TESTS FOR MANAGERIAL AND SUPERVISORY WORKERS

Employment tests have played a very small part in the selection of men for managerial and supervisory positions. This is probably accounted for by the fact that the work and personal characteristics of men considered for these positions are known, either through observation of their behavior in lower positions in the organization or through acquaintance with them in other organizations. Since the work in managerial and supervisory positions involves considerable responsibility, it is a wise procedure indeed to select people who have been under observation for long periods of time.

One prime difficulty in developing tests for selecting persons for such jobs is the lack of adequate criterion measures. It has been found difficult to develop a criterion of job proficiency for supervisors that is both meaningful and predictable. As a consequence there have been a number of reports of negative results. This does not mean that the success of supervisory workers cannot be predicted by tests. Rather it means that more experimental research work needs to be done in this area. To illustrate the fact that tests are useful in this occupation, we shall cite three investigations in which satisfactory results were obtained.

Beckman administered a personality inventory designed to measure ascendance-submission to a group of 35 chain variety store managers on whom service ratings were available.[36] The correlation obtained was only 0.27. However, of a group of 110 managers who were given the test, only 25 per cent of those who left the company within a year showed "ascendant" scores, whereas 80 per cent of those who remained achieved such scores. Stevens and Wonderlic administered the Otis Mental (intelligence) Test to 160 office managers. These managers were classified into two groups, those who had been severely criticized and those who were relatively free from criticism.[37] The average number of errors on the test made by the first group was 23, and that made by the second group was 12. Only one-fifth of the criticized group made fewer than 15 errors, while three quarters of the noncriticized group did so. Shuman has reported the effectiveness of tests in the selection of foremen in the aircraft industry.[38] The results obtained with groups of foremen in three different plants are given in Table 49. In all cases ratings by supervisors constituted the criterion of proficiency. In one plant none of the three tests employed gave satisfactory predictions of success. In both of the remaining two plants, however, good results were obtained from an intelligence test and from a test of mechanical comprehension.

TABLE 49.—THE VALIDITY COEFFICIENTS OF THREE TESTS IN THE PREDICTION OF THE SUCCESS OF FOREMEN AS EVALUATED BY RATINGS BY THEIR SUPERVISORS

Type of test	Aircraft plant		
	A	B	C
Intelligence	0.39	0.05	0.66
Spatial relations	0.47	0.08	0.14
Mechanical comprehension	0.47	0.02	0.65

INTELLIGENCE TESTS

Of the many types of tests which have been used in personnel procedures, intelligence tests have been used most frequently. Intelligence tests have been employed in the selection and classification of workers for almost all varieties of jobs from the unskilled to the administrative and professional. This extensive use reflects the fact that these tests have been applied most uncritically and with little attempt to understand the true nature and purpose of the tests. They have been applied and badly misused in situations for which they were totally unsuited. The many unsatisfactory results that have thus been obtained have overshadowed the instances where the tests have proved to be of value. As a consequence, intelligence tests have earned an undeserved reputation of being of little value in solving many different selection and placement problems in industry.

The major characteristic of intelligence tests which is so often overlooked, is that they are intended primarily to give a very general and over-all picture of an individual's abilities. Like tests of any other kind, intelligence tests measure several different abilities. Important differences between intelligence tests and other tests are that intelligence tests tend to measure a large number of different abilities, and the abilities that they do measure tend to be of a more abstract and purely intellectual nature, such as those important in school and academic success. This is best shown by the types of items ordinarily included in an intelligence test. One finds in them questions on vocabulary, sentence completion, arithmetic, analogies, meaning of proverbs, reasoning problems, etc.

If the purpose and nature of intelligence tests are kept in mind, it will be apparent that these tests will have limited use in business and industry. It cannot be expected that they will be of value for all personnel problems. Since there has been considerable research on intelligence tests, there is substantial knowledge concerning the kinds of situations in which they will be effective. In the following paragraphs we shall consider intelligence tests as indicators of potentiality to learn a job, to produce on a job, to continue on a job, and to be promoted. In addition the relationship between intelligence test scores and the hierarchy of occupations will be discussed.

Intelligence Tests as Indicators of Potentiality to Learn a Job.—For over three decades, evidence has been accumulating concerning the effectiveness of intelligence tests in the prediction of school success. For secondary schools, the coefficient of correlation between test scores and grades is of the order of 0.60. The main consideration for industrial psychology, however, is not the prediction of secondary school success but rather the prediction of success in various trade and technical specialties.

Formal training in the various types of clerical jobs and mechanical trades is generally conducted in institutions of about the secondary-school level. Although the evidence is not wholly adequate, it appears that the predictive effectiveness of intelligence tests for these applied subjects is somewhat less than for the more academic subjects. In general the coefficients of correlation are about 0.50 for the clerical courses and 0.40 for the mechanical courses. In view of the semi-academic nature of the subject matter in the clerical courses, the validity of intelligence tests in this respect is not surprising. The fact that the scores are related in a significant manner to grades in mechanical courses, however, is less often recognized.

The above results demonstrate the usefulness of intelligence tests in the prediction of success in formal training curricula. In business and industry, however, most of the training is of a more or less informal sort involving on-the-job training. The extent to which the preceding findings for formal training can be generalized to cover this type of training is difficult to determine. It would be better, of course, to observe directly the usefulness of intelligence tests in the prediction of success in on-the-job training. Insofar as the clerical occupations are concerned, there is no satisfactory evidence. For the mechanical trades there is some evidence from the use of intelligence tests in the selection of apprentices. The findings in these situations indicate that a validity coefficient of about 0.40 might be expected.[39]

Intelligence Tests as Indicators of Potentiality to Produce on the Job.—It would be surprising to find that intelligence test scores are related in any manner whatsoever to sheer amount of production on the job, when the generally academic and abstract nature of the contents of these tests is considered. Nevertheless, research findings indicate that intelligence test scores, to some extent, do predict productivity on the job. The validity coefficients for intelligence tests for 84 different groups of employed workers are summarized in Fig. 25. In each case job success was measured directly in terms of output or supervisors' ratings of productivity. A variety of different intelligence tests were used. From this figure it is apparent that intelligence tests give a relatively satisfactory prediction of output in clerical jobs, that they are less satisfactory for sales jobs, and are of little use in mechanical jobs. For the clerical jobs, 39 per cent of the validity coefficients were 0.40 or above, and 38 per cent were 0.19 or less; for the sales jobs, 15 per cent of the validity coefficients were 0.40 or above and 55 per cent were 0.19 or less; and for the mechanical jobs, none of the validity coefficients was greater than 0.39, and 59 per cent were 0.19 or below.

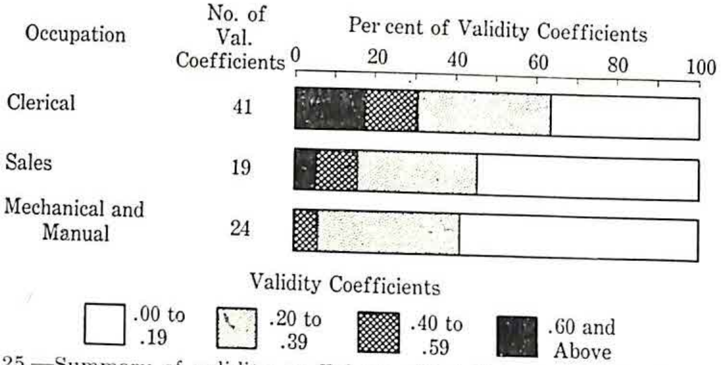

FIG. 25.—Summary of validity coefficients of intelligence tests in the prediction of productivity of workers engaged in clerical, sales, and mechanical and manual occupations.

Intelligence Tests as Indicators of Ability to Continue on the Job.—As was pointed out in the chapter on measures of job success, one of the more important personnel problems is labor turnover. Most jobs require a training period during which the individual is on an employee status. In addition to the fact that he is nonproductive, although he is being paid wages, there are usually additional training costs. Therefore a new worker who completes his training but shortly thereafter leaves the job is a distinct liability. Furthermore such a separation is likely to disturb operations through interruption of work schedules. Finally there is the fact that the longer an individual remains on the job, the more proficient he becomes through increased experience. All told, then, the ability to continue on the job is an important consideration.

Several investigations have shown that intelligence test scores are related to labor turnover. For most jobs there is an optimal range of scores within which labor turnover is at a minimum, either higher or lower scores being associated with an increase in turnover. In many cases fairly exact minimum and maximum scores can be set. In Table 50 are shown some typical results for a group of inspector-wrappers and cashiers.[40] It will be noted that those workers with intelligence test scores between 30 and 39, on the average, remained on the job for the longest time, whereas those with either higher or lower scores remained on the job for shorter periods of time.

TABLE 50.—INTELLIGENCE TEST SCORES IN RELATION TO LENGTH OF SERVICE AMONG CASHIERS AND INSPECTOR-WRAPPERS

Test Score	Average Length of Service, Days
90 and above	35
80–89	87
70–79	96
60–69	100
50–59	107
40–49	142
30–39	156
20–29	91
10–19	3

These minimum and maximum scores vary considerably with the nature of the job. In general they are higher for the more complex jobs and lower for the simpler ones. This is illustrated by data presented in Table 51.[41] It will be observed in this table that, as the difficulty of the job decreases, the proportion of individuals with high scores—110 and above—who stay on the job decreases. Similarly the proportion of those individuals with low test scores—80 and below—who stay on the job increases as the work becomes easier.

TABLE 51.—THE RELATIONSHIP BETWEEN LABOR TURNOVER, INTELLIGENCE TEST SCORE, AND DIFFICULTY OF THE OCCUPATION

Grade of work	Turnover of those scoring above 110 points, per cent	Turnover of those scoring below 80 points, per cent
A (hardest)	41	66
B	53	58
C	72	50
D	100	62
E (easiest)	100	37

Intelligence Tests as Indicators of Potentiality for Promotion.—Since in many instances workers in a lower job furnish the pool of personnel to be placed in higher jobs, measures of potentiality for promotion are an important consideration. In Table 52 figures are given revealing the relationship between the intelligence test scores of some 300 clerical workers, obtained at the time they were hired, and the job level they achieved some time later.[42] It is apparent that those individuals who made low scores on the intelligence test at the time they were hired tended to remain in the lower jobs, whereas those who achieved high scores tended to be promoted to higher jobs. With clerical and office work, therefore, intelligence tests do give a measure of an individual's potentiality for promotion.

TABLE 52.—RELATIONSHIP BETWEEN INTELLIGENCE TEST SCORES OF CLERICAL WORKERS AT THE TIME THEY WERE HIRED AND JOB LEVEL ACHIEVED SOME TIME LATER

Intelligence test score	Low job, per cent	Middle job, per cent	High job, per cent	Total, per cent
180 and above	4	42	54	100
160–179	9	71	20	100
140–159	33	59	8	100
139 and below	87	13	0	100

Intelligence Test Scores in Relation to the Hierarchy of Occupations.—As was pointed out in our earlier discussion of occupational analysis, when the various occupations are placed in rank order it is customary to place the professions at the top of the list, followed in order by the managerial and supervisory jobs, the clerical jobs, the sales jobs, and finally the various manual and mechanical jobs arranged in descending order of skilled, semiskilled, and unskilled. It is ordinarily considered that this ranking is based upon the complexity of the tasks involved in the different occupations. It is generally believed that an individual who performs adequately in a job at a given level can also perform adequately all jobs that fall at lower levels.

There have been many studies of the relationship between occupational level and intelligence test scores. The same general results have been obtained in all such investigations. Typical of the results are the findings shown in Table 53, which gives the scores on an intelligence test of soldiers in the First World War in relation to their civilian occupation.[43] It will be observed that as one descends the occupational scale there is a progressive decrease in the average intelligence test score.

The question arises as to how this relationship between intelligence test score and occupational levels can be explained. In a previous paragraph it was pointed out that the common point of view holds that the ordering of jobs is based primarily upon the complexity of the tasks. The complexity of the tasks that an individual can perform is considered to be a direct function of his general intellectual ability. From this argument it follows that an individual of a given intellectual ability can perform all jobs whose complexity requires that particular intellectual level and all simpler jobs, since their intellectual requirements are less. Furthermore he should not be able to perform in a satisfactory manner any jobs at higher levels.

The variation in scores of persons found in any given job is reflected in the values of Q_1 and Q_3. Twenty five per cent of the persons in a job get scores lower than the value of Q_1, and 25 per cent get scores higher than the value of Q_3. In Table 53 it will be observed that for any given job the variation in scores for persons holding it is considerable. Thus, although the average score of structural-steel workers was rather low, exceeding the scores of only 20 per cent of the population examined, one-quarter of the structural-steel workers earned scores in the upper half of the population. Similarly, although the average score of photographers exceeded the scores of 70 per cent of the population and consequently is fairly high, the lowest quarter of the photographers earned scores in the lower half of the population. Since individuals in this lowest quarter of the photographers were actively engaged in their occupation, it may be presumed that whatever the minimum intellectual requirements for the job of photographer might

TABLE 53.—SCORES ON AN INTELLIGENCE TEST IN RELATION TO OCCUPATION

Occupation	Percentile score		
	Median	Q_1	Q_3
Engineer	98	83	99
Accountant	93	80	96
Physician	90	82	98
Teacher	88	76	95
Chemist	87	75	93
Draftsman	87	69	93
Executive	83	66	93
Bookkeeper	78	63	90
Clerk	76	60	88
Photographer	70	48	82
Telegrapher	70	46	83
Musician	67	46	82
Electrician	66	46	83
Stock clerk	66	45	81
Druggist	64	50	81
Locomotive engineer	60	42	72
Policeman	56	35	72
Toolmaker	55	39	73
Plumber	54	33	71
Lathe hand	53	33	73
Chauffeur	53	32	73
Tailor	53	32	72
Lineman	52	32	71
Butcher	50	29	70
Printer	49	24	74
Blacksmith	48	28	68
Painter	48	27	66
Bricklayer	47	26	67
Cobbler	45	27	62
Barber	44	23	64
Sales clerk	41	27	76
Boilermaker	40	20	60
Teamster	39	19	59
Miner	38	29	58
Mason	29	8	49
Shoemaker	24	8	46
Lumberman	24	7	51
Structural-steel worker	20	9	51
Cook	16	7	46
Textile worker	14	7	49
Sheet-metal worker	11	6	35
Laborer	10	5	36
Fisherman	9	6	49

be, at least as indicated by intelligence tests, it certainly must be quite low.

Studies of groups scoring low on intelligence tests support the notion that the minimum intellectual levels, below which various jobs cannot be performed successfully at all, are quite low. Examples of minimum required scores are shown in Table 54.[44] It is apparent that even persons with quite low mental ages may perform certain jobs in an adequate manner. For example, an individual with an intelligence test score no greater than that of a six-year-old child can handle freight or operate a mangle in a satisfactory manner. Since the proportion of persons in the general population falling below these minimum levels is very small, such requirements would seem to be quite an unimportant problem in business and industry. It may be concluded therefore that general minimum intellectual requirements cannot be considered a primary factor in determining the relationship between intelligence test scores and occupational level.

TABLE 54.—MINIMUM MENTAL AGES FOR SEVERAL JOBS

Mental age, years	Boys	Girls
5	Wash dishes	Follow a pattern in simple sewing
	Feed and fold from a mangle	Pare vegetables
6	Mix cement	Operate a mangle
	Handle freight	Crochet open mesh
7	Rough painting	Cross-stitch
	Simple shoe repairing	Hand ironing
8	Cut hair and shave	Operate scarf loom
	Garden work	Make dresses cut by others
9	Foot-power printing press	Fancy basketmaking
	Mattress and pillow making	Plain cooking
10	Sign painting	Operate sweater machine
	Shellacking and varnishing	Fancy laundry work
11	Storekeeping	Simple library work
	Greenhouse attendant	Power sealing in canning plant

In the light of the data now available, it is not possible to set down all the factors that might contribute to this relationship between intelligence test score and occupational level or to describe the relative importance of the factors known to condition this relationship. It is quite clear from the results cited in the foregoing discussion that the human factors measured by intelligence tests are related to success in learning a job, to the level of productivity achieved on the job, to the length of service attained on the job, and to the level of job reached through promotion. These generalizations may not hold for every job, but the results on which they are based have included both a wide range of jobs and a wide variety of intelligence tests, and therefore considerable credence can be given them.

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CHAPTER IX

DEFINITION AND MEANING OF EFFECTIVE WORK

Before we can evaluate the methods and conditions of industrial work, it is necessary to have some understanding of the nature of human work in general and to know how its effectiveness can be gauged. This chapter will deal with some of the characteristics of human work. The concepts of efficiency and fatigue will be examined, since they are the bases now typically offered for evaluating such work. Their value as criteria in determining the effectiveness of work will be discounted, and suggestions will be made for establishing a broader base on which human work in industry should be evaluated.

THE NATURE OF HUMAN WORK

It is not a simple task to give a satisfactory definition of human work. A beginning can be made by modifying the usual definition of work given by the physical scientist. Human work may be considered as the expenditure of energy by a person in effecting a change in his behavior. The first phase, that of energy expenditure, involves many complex physiological and biochemical processes, including the ingestion of food, the transformation of food into glycogen, the storage of glycogen in liver and muscles, and the oxidation of glycogen with the resultant release of energy. The second phase, that of changing behavior, requires a description of the changes in bodily tissues resulting from this release of energy, and includes changes in sense organs, muscles, glands, and nervous system.

A complete description of the foregoing conditions would be a satisfactory explanation of work provided the machine referred to was not a living organism. With living machines the picture is more complex, and with human beings it is exceedingly complex. Particularly in the behavior aspect it has been impossible thus far to give an adequate description of what takes place. Behavior changes cannot be fully described or understood solely in terms of physiological and neurological changes but must be studied at higher levels of a psychological and sociological nature. In addition to being a sensori-neuromuscular machine, man is an organism capable of conscious thought and reflection, responding in an environment containing others of his kind. There is no doubt that these higher level responses, such as thinking, reasoning, desiring, willing, etc., and the conditions in the individual upon which they depend, such as aptitudes, abilities, interests, attitudes, motives, etc., are all directly conditioned by physiological and neurological changes, but to be fully understood and explained they must be studied on psychological and sociological levels of causation.

The responses that the human individual is capable of performing can be arranged arbitrarily in an order of increasing complexity, and it will be found that the energy cost, both physiological and psychological, increases in a rough way with this order of complexity. At the lowest level are the vital activities, the various organic processes basic to life. Next are the postural responses, which are muscular reactions supporting the body in space. They form a substrata upon which all other responses are superimposed. Of higher complexity are the phasic reactions, which involve movement of the body or of its parts in space. Walking, talking, and typing are good examples. These reactions vary in the size of the muscle groups activated, sometimes involving large masses, as in walking, and sometimes small masses, as in talking. Next in order of complexity are the mental reactions, which vary widely in themselves from simple responses of remembering the day of the week to the complicated rational behavior involved in devising the atomic bomb. All the responses, from the simplest reflex of digestion at one end to the most complex rational activity at the other, are manifestations or resultants of the expenditure of energy in what is called "work."

Physical versus Mental Work.—Human work is usually divided into physical work and mental work. This dichotomy has been an old and much-debated one in philosophy, arguments being presented as to whether the mind should or should not be conceived as something different from the body. It is natural in studying human work that the concepts of the past be adopted, and that the work of the individual attributable to his mind be called "mental," and that attributable to his body be called "physical." In the foregoing paragraphs, however, it was not found necessary to make this distinction. It was necessary to point out that the reactions were not to be conceived solely as being disturbances in sensori-neuro-muscular tissues. Reactions can be dealt with as integrations of responses, as totalities of behavior, as global adjustments, and these usually carry the very little understood attribute of consciousness. It must be accepted that these responses are no less real, insofar as energy expenditure is concerned, than are other forms of response.

Although there is no clear distinction between mental and physical work insofar as the nature of the underlying response tissues is concerned, it is convenient to separate mental reactions from the more purely motor reactions. In terms of the psychological and sociological implications the distinction is important. The term *mental work* therefore will refer to those types of activities in which remembering, thinking, reasoning, judging, and the like are preponderant, and physical work, those activities in which these responses are not important, but where the speed and coordination of muscle groups are the main concern of the individual.

Cause and Effect in Response.—At first glance, the cause-and-effect sequence in human work appears simple—there is an expenditure of energy in the sensori-neuro-muscular tissues, and, *ipso facto*, there is response at some one of the levels previously described. This description, however, treats response only as a resultant, whereas it also functions as a cause. In the complex interrelation of nervous patterns, there exists a structural basis for a complex interaction of responses. Responses then occur in a sequence of change, and function in one situation as causes and in another as effects from preceding causes. As causes they condition the energy expenditure underlying subsequent behavior. As an example, consider workers' attitudes toward the supervisor. A worker's attitude forms as the resultant of a large number of factors functioning in situations where both worker and supervisor are involved. It is a response—a form of behavior that the individual learns through his experiences. In turn it functions as a cause in determining other behavior; *i.e.*, it affects the worker's dealings with his supervisor. Attitude is not less real just because it is not objectively observable as is walking or talking, and its effects upon behavior are not less real for similar reasons.

Sources of Information about Human Work.—Brief mention should be made of the sources of our knowledge of human work. Knowledge of the energy-expenditure phase has progressed to a rather high level. Physiologists, neurologists, and biochemists have learned the nature of the transformation of food into glycogen, and the storage of glycogen in the reacting tissues. The transformation of glycogen into energy as it takes place in the microscopic tissues of the muscles and nerves is now in the process of being discovered and described. The underlying oxidative changes resulting in waste products are known, and the various detrimental effects of the accumulation of these toxic substances are under study. These sources of information are leading to a more comprehensive understanding of the sensori-neuromuscular changes involved in work.

A study of the nature of work that is leading to a better understanding of the worker's accomplishments is in terms of the global behavior of the worker. This is the kind of study conducted by the psychologist, the sociologist, the human engineer, or the executive in industry. The nature of the processes involved in the work is judged from the variations discovered in the end products. Such characteristics as the amount of production, wastage, accidents, and other measures of worker performance are used as reflections of underlying processes, and some notion of the functional characteristics of these processes can be obtained from variations in the quantity and quality of the end results. It will be found that certain of these results are more readily observed and described than others. Furthermore, some of them are considered to be of greater importance than others in reflecting the worker's proficiency. Disagreement can be found in the relative weights assigned to the various product criteria, and these differences often are traceable to differences in the point of view concerning the worker's share in the profits of industrial production.

Emphasis upon Efficiency.—With the development of mass-production methods and the extension of high standards of living to nearly everyone, there has arisen a need for speed and effectiveness in industrial processes. American industry has been able to make its great contribution to the general living standards by streamlining production and removing all points of inadequacy. Efficiency engineers have been hired to hunt down and eradicate work methods that do not meet high standards of productivity.

Most of the efforts to streamline production have come from management, and so it can be expected that the results would tend to favor the employer. In the beginning, with narrowed vision, management evaluated most changes in terms of the profit motive. In recent years, with wider vision, interests have broadened to include the working environments of their employees. Management has been considering the criterion of the workers' comfort and safety in conjunction with that of profits, in its attempts to improve production. To the surprise of many, production has increased and brought with it an increase in profits when changes were introduced solely on the criterion of the worker's improvement. At the present time there is a further broadening of management's perspective, which is leading it to include other kinds of worker adjustments as necessary criteria to be used in the evaluation of industrial work. On the basis of past results it can be safely predicted that the application of such all-inclusive criteria will again result in increased returns to the employer.

This gradual change in the perspective of the industrialist points up the need for a reexamination of some of the concepts used in evaluating past changes. Efficiency is one of these concepts. In the past it has played an important role in the employer's thinking, and frequently it has been the sole criterion utilized. Fatigue is another concept that has been closely associated with efficiency in the thinking of management. In anticipating the changes of the future it will be profitable to reevaluate these two concepts as they apply to the worker on the job.

The Role of Efficiency and Fatigue in Evaluating Human Work.—Traditionally, different methods and conditions of industrial production have been evaluated in terms of efficiency and fatigue. A review of the classic writings in the field of human work will reveal numerous references to these two concepts. One method or condition of work will be said to be superior to another because it is more efficient or less fatiguing. Very long hours of work will be condemned because efficiency drops and fatigue increases markedly. Discussions of time-and-motion economy will claim marked improvements due to increased efficiency. Rest pauses will be justified on the grounds that they overcome fatigue. High efficiency coupled with low fatigue, then, have been the goals sought, and methods or conditions of work that achieve or approximate these goals are designated as being superior to those which fall short of these standards.

However, if the literature concerned with methods and conditions of work is critically evaluated, it will soon become apparent that these concepts have not been adequately defined. Relative to efficiency, it will be seen that in many, if not most, cases the authors are not discussing efficiency at all. Rather, they are likely to be concerned only with speed of production. Furthermore, fatigue will be found to be quite a nebulous concept. Discussions of fatigue are likely to be characterized by circular reasoning, which completely invalidates any conclusions that are drawn. Finally the reader will not be content with the evaluation of human work in terms of these restricted concepts. He will object to statements that night work is wholly adequate simply because efficiency and fatigue are about the same as that found in the day shift. Certainly he will raise questions concerning the effects upon home life, health, and social adjustment of placing workers on the night shift. It is therefore obvious that the concepts of efficiency and fatigue need close and critical reexamination, and the whole problem of the meaning and definition of effective work calls for a more detailed consideration.

THE CONCEPT OF EFFICIENCY AS APPLIED TO HUMAN EFFORT

The General Concept of Efficiency.—Efficiency has a very exact definition. It is given as the ratio of output to input. Thus a machine that requires 40 units of energy in order to produce 20 units of work is said to have an efficiency of 50 per cent. A machine that requires the same input, but only produces 10 units, is considered to be less efficient. Similarly, if in carrying out their jobs two workers have the same input but one produces only half as much as the other, the former is said to be less efficient. Again, if, under two conditions of work, production is the same, but under one condition of work, greater human input is required, this condition of work is said to be less efficient.

Under certain circumstances, the output of two machines might be known, but not their input. In such a case their efficiencies cannot be determined, and therefore there is no basis for a comparison. Thus, if one machine turns out twice as many completed articles as another, the conclusion cannot be drawn that it is the more efficient, since its operation might require three or four times the amount of fuel or power. Similarly, if under one condition of work men produce twice as much as under another, one cannot say that the former is the more efficient, since it might demand three or four times more energy expenditure from the individuals. Whether a machine or a man is involved, efficiency can not be determined for either of these situations. All that can be said is that there are differences in output. No information is available relative to the costs required to achieve the production.

The Problem of Determining Human Efficiency in Industrial Work. In the industrial situation it is very difficult if not impossible to obtain direct measures of human input. For example, sometimes the human costs of work are determined by the speed of the metabolic processes of the body. To obtain the pertinent measurements it is necessary to attach a rather elaborate and cumbersome apparatus to the worker. This apparatus is likely to interfere with his movements and thereby change the nature of the operations. Furthermore the individual to whom such apparatus is attached ordinarily needs some time to adjust himself to it. Thus a disturbance in the working situation is introduced, so that it is not equivalent to the actual job conditions. The results therefore may be in error due to measurements being taken in a somewhat different and artificial situation.

Owing to the difficulties of obtaining in the working situation data relative to the physiological changes in the worker induced by the work, most of the investigations of the subject have been conducted in the laboratory or under semi-laboratory conditions. Data obtained in the laboratory, however, are not necessarily pertinent to any particular job in question.

Because of a general distrust of laboratory findings, and perhaps, to some extent, because of their unwillingness to concern themselves with material and methods with which they are not familiar, the general tendency among industrialists has been to consider output alone as a sufficient measure of efficiency. When this is done, two important assumptions are made: first, that human input and costs are the same regardless of the methods and conditions of work used, and, secondly, that the input and cost are the same for all the workers involved. Thus, when a new method of work is found to increase output 20 per cent, it is assumed that input remains the same, and efficiency is increased by 20 per cent. Numerous investigations, principally from the physiological laboratories, have demonstrated the invalidity of such an assumption. Certain results, to be described in the following paragraphs, will be illustrative in showing that, under different conditions of work, physiological costs vary markedly, and that there are wide individual differences in energy consumption on the part of different workers apparently doing the same task.

Examples of Attempts to Measure Human Input and Efficiency by Physiological Costs.—A variety of different indices have been used as measures of physiological costs of different methods and conditions of work. Typical indices of metabolic changes in the body are the amount of oxygen consumed and the amount of carbon dioxide given off, or the amount of heat liberated by the person during work. In some cases, various measures of cardiac changes are employed, such as pulse rate and blood pressure. In determining efficiency, such physiological indices are generally compared with the amount of work for different individuals, or for different methods or conditions of work. Some typical results obtained in this area are given below.

Sherman has reported the energy costs of various common tasks.[1] He measured the energy in terms of heat expenditure, using the large calorie as the unit of measurement. The energy liberated by the resting individual is used as a standard, and the amount expended over and above this is considered the energy cost of the particular task performed. Table 55 gives the energy requirements for several different activities. It will be seen that typing rapidly requires almost double the amount of energy expended while lying still, and carpentry, metal working, and painting, about three times as much.

TABLE 55.—RELATIVE ENERGY EXPENDITURE FOR SEVERAL COMMON TASKS

Task	Relative Calories per Hour
Lying still	100
Dressing or undressing	153
Typewriting rapidly	182
Ironing, dishwashing	187
Walking 2.6 miles per hour	260
Carpentry, metal working, painting	312
Walking 3.75 miles per hour	390
Sawing wood	623
Running 5.3 miles per hour	741
Walking upstairs	1,430

Grollman obtained measures of physiological costs of individuals executing simple arm movements.[2] From his data the relative efficiency of the different movements can be computed. The results, given in Table 56, show that flexing and extending one arm is slightly more efficient, on the average, than alternately flexing and extending both arms. Furthermore, doing this task twice per second is about 80 per cent more efficient than doing it once per second. Faster rates of work, then, while requiring greater input on the part of the individual, do not have requirements in proportion to the increased rate of work.

A study of the physiological costs of wheeling a barrow has been made by Crowden.[3] This investigator found a wide range of individual differences among men in terms of physiological costs. For four men of about the same skill in barrow wheeling, the relative amount of oxygen consumed while doing the same task was 100, 161, 171, and 188, respectively. Thus, the physiological costs for one individual were nearly twice as great as those for another. The results of the experiment, wherein the physiological costs were compared with the rate of wheeling the barrow, are shown in Table 57. It is apparent from these findings that there is an optimal speed of work, with both slower and faster speeds being more demanding.

From the foregoing three studies, several conclusions can be drawn, viz., (1) different types of work require different amounts of energy; (2) different methods of accomplishing the same task require different amounts of energy when the energy expenditure is measured by the same index; and (3) the relative energy expenditure required for different tasks varies with the different types of indices used. In these and other studies it has been demonstrated that different individuals require different amounts of energy for accomplishing the same tasks, and that the relative amounts required by different individuals vary with the method used in measuring the energy expended.

TABLE 56.—PHYSIOLOGICAL COSTS AND EFFICIENCIES OF DIFFERENT METHODS OF WORK

Kind of work	Relative amount of work	Physiological costs			Relative efficiency		
		Oxygen consumption, per min., cc.	Arteriovenous difference, cc. per min.	Cardiac output, cc. per min.	Ratio of work to oxygen consumption	Ratio of work to arteriovenous difference	Ratio of work to cardiac output
Flexing and extending right forearm once per second.	100	286	59	4.8	100	100	100
Flexing and extending right forearm twice per second.	200	340	65	5.2	167	181	185
Alternately flexing and extending both forearms, each every other second.....	100	315	73	4.3	91	81	112

TABLE 57.—PHYSIOLOGICAL COST OF WHEELING A BARROW AT DIFFERENT RATES

Rate	Oxygen consumption, cc.	Relative values
Slow walk..........................	1,560	112
Normal brisk walk..................	1,240	100
Very quick walk....................	2,040	164
Gentle run.........................	1,960	158

The fact that different measures of input are not perfectly or even very highly related means that physiological input cannot be thought of as a single variable. It is a complex variable with many aspects not necessarily highly correlated. Thus, if one index of physiological costs were employed in computing efficiency, the results obtained might be different than if some other index of costs were utilized. The fact that individuals do differ in their input when doing the same task means that it cannot be assumed that costs are the same for all individuals, and this is true regardless of the method used in measuring the energy expended. Output, therefore, cannot be accepted as a satisfactory measure of the demands made on the individual in accomplishing the task.

Mental versus Physiological Costs.—The concept of physiological costs as a basis for determining efficiency is very tenuous in view of the fact that these costs can be measured in a variety of different ways that are not highly correlated. But even if the various physiological indices were found to give consistent results, the procedure of basing the measurement of human efficiency on input, measured solely in physiological terms, is open to question. The physiological costs are only one aspect of the total demand made upon the individual.

When a worker characterizes a job as "hard work," he may be referring not only to the physical effort he must expend but also to the mental effort, *i.e.*, to his subjective feelings of effort. In industry it is customary to call a job a hard one if it requires a high degree of physical effort, but from the point of view of the individual workman this might not be true. Psychologically speaking, it is probably harder to inspect containers for flaws and proper labeling as they come down a production line one right after another, making sure that none is missed, than to pack these containers into cartons and carry the containers to a truck or conveyor belt; this may be true in spite of the fact that the first operation demands far less physiological cost than the second. Mental and physical effort are therefore demonstrably different, and it is incorrect to assume that physical effort is a direct measure of mental effort.

Psychological Input and Costs.—It is too easy to underrate the importance of feelings of effort simply because their magnitude or extent cannot be measured in nice quantitative terms such as calories or degrees. It is quite true that feelings of effort cannot be measured in any reliable fashion. Much work needs to be done in this field. At present one must be content with qualitative statements from workers.

Besides the difficulty of measurement, another reason that mental effort has been overlooked in most industrial investigations is that it has been confused with fatigue. Fatigue refers to the aftereffects of work, whereas feelings of effort refer to the immediate demands of the work. If the reader doubts the separate existence of feelings of effort, let him try to multiply two three-place numbers in his head. He will feel little or no aftereffects, *i.e.*, fatigue, but unless he is a lightning calculator he will know that he has done some work and that some mental effort was required.

Mental effort therefore is as important in the calculation of human input as are physiological costs. Under present conditions in this country it is doubtful whether there are many occupations where the work involves such a high physiological cost that it is deleterious to the health of the worker. Legislation relative to working conditions, medical inspection and examinations, and union-management agreements almost ensure that the physical demands on the worker and the physiological costs to him are not excessive.

It cannot be said that this is also true with respect to the psychological demands on the individual and the costs in terms of mental effort. To a large extent such demands and costs are unknown; we are simply without pertinent data. The depreciation in a machine as the result of its operation can be accurately estimated in quantitative terms. To some extent the same is true of the physical costs to the worker. The evaluation of the psychological or mental costs to the worker, however, is conspicuous by its absence. This is a field toward which much study and research must be directed. Employers can ill afford to postpone its consideration much longer, because it holds the solution of many of the problems plaguing industry today.

FATIGUE

For at least a century, fatigue has been the subject of a great deal of experimental and systematic study. In view of the many investigations one would suppose that the relevant problems are isolated and defined, and the basic concepts clarified and well understood. The fact of the matter is that the issues are still confused, and disagreement is prevalent throughout the field. In many cases the findings from scientific investigations do not check with common experience; in other cases, laboratory findings are found to be inapplicable to industrial situations. Thus, although there are many sound experimental results available, their interpretation has led to numerous difficulties and inconsistencies.

The Ambiguity of the Term Fatigue.—Ordinarily the term *fatigue* is used to describe a general state of the individual, a state resulting from continuous activity. One widely accepted notion claims that fatigue may manifest itself in different ways, but all manifestations will be of the same order. If one index or sign of fatigue shows a change, then every other index or sign will change in the same manner and to the same degree. It is this concept of fatigue that has caused so much confusion.

As several writers[4] have pointed out, an analysis of the manner in which the term fatigue has been used in various discussions of the subject reveals three very different conditions of the individual to which the term is applied, viz., (1) the physiological condition of muscles and nerves after activity, (2) the reduction in the amount and quality of work after activity, and (3) the feelings of tiredness after activity. If the term fatigue is to refer to all three of these conditions, it must be shown that they vary concomitantly and invariably, or else the term will be completely ambiguous. It therefore becomes necessary to consider evidence relative to the extent to which these three conditions are related.

Relationships between Different Indices of Fatigue.—Changes in work output have been shown to be a function of such disparate factors as conditions of illumination and degree of motivation. Output therefore cannot justifiably be taken as reflecting solely the accumulation of the chemical by-products of exercise in the muscles and nerves.[5] Similarly, studies of the relationship between feelings of tiredness and output show little or no relationship between these two conditions. The lack of any high relationship is common experience. The businessman after a "tiring" day at the office can display a high level of activity on the handball court. Evidence also is afforded by laboratory experiments. Poffenberger had subjects insert words into sentences for a 5½-hr. period.[6] At regular intervals the number of items of completed work was noted, and the subjects indicated their feelings of tiredness on a rating scale. The results indicated that whereas work output fluctuated irregularly, showing no general decrement, the subjects reported increasing feelings of tiredness.

Further evidence comes from studies of the energy expenditure from mental work. Benedict and Benedict had subjects do mental work for a period of several hours during which measurements were made of their energy expenditure through oxygen consumption and carbon dioxide production.[7] These experimenters found that, for the experimental time used, the mental work required only a very slight amount of energy. This very small amount of energy consumed was greatly out of proportion to the mental effort the subjects felt, and would be an insignificant amount when compared with the energy expended in doing physical work for the same period of time.

Fatigue an Inadequate Explanatory Concept.—A better understanding of the use of the term *fatigue* will be obtained from tracing the logic underlying its development. The primary fact from which the concept originated is that the worker's performance suffers deterioration with continuous work. This deterioration was noted in the amount of work done, the accuracy of the work, the tendency to have accidents, the feelings of tiredness, the desire to give up or to seek rest, and other similar signs. The physiologist, at first working with animals and later with human beings, discovered certain physiological concomitants of continuous work, such as increased blood sugar, oxygen consumption, carbon dioxide production, lactic acid production and other similar changes. These changes are also considered as resulting from continuous work.

The word fatigue was coined to stand for the condition present in the individual from which these different changes arose; *i.e.*, it referred to a general state of the organism that caused these changes. This general state is not observable but is known only through the various signs noted above. Fatigue now became the cause of the fluctuations in production, the increase in feelings of tiredness, and the changes in the physiological processes. If these diverse phenomena were to be adequately explained as resulting from a single general state, then there would have to be a high correlation among the amounts of their expressions. This was found not to be the case. The question then arose as to whether there is a single general state of the organism, caused by continuous work, that could be described by these various kinds of signs.

It is apparent that, factually, fatigue is a term merely standing for various effects of continuous work. It follows that, if the effects of the work are diverse and uncorrelated, the term will have several meanings and therefore will be ambiguous. This actually is the state of the concept at the present time; the term is not useful because it has too many meanings.

Because of its broad scope, certain writers have suggested that the term be discarded.[8] Others have suggested adopting three meanings according to the nature of the signs observed, *i.e.*, industrial fatigue (production), physiological fatigue, and mental fatigue. When examined closely this is not found to be a satisfactory solution. It was noted above that the various changes resulting from continuous work were not found to be highly correlated. This, as shown, precludes the use of the term fatigue as standing for a unitary condition within the individual. On the other hand the various signs are not mutually unrelated; *i.e.*, there is not a zero correlation between them. This would be the necessary condition for setting up three independent meanings of the term fatigue as suggested above. Unless this condition is fulfilled, there is little to be gained from adopting three meanings.

A better procedure would be to state exactly the signs or changes being described, *e.g.*, whether drop in quantity of output, increased desire to stop work, or excessive accumulation of lactic acid is involved. These are facts, and in the study of continuous work in industry these and similar facts are the sources that will provide the cues for any improvement of methods or conditions of work. In the following descriptions the term fatigue will not be used; rather, characteristic changes from continuous work will be described.

SOME CONCOMITANTS OF CONTINUOUS HUMAN WORK

Physiological Concomitants.—Certain of these physiological changes have been mentioned above in the discussion of the concept of efficiency. Some additional comments should be made on the general mechanisms involved in some of these changes. Activity of any kind involves the oxidation of glycogen and other compounds stored in the tissues. The general term for this process is *metabolism*. To accomplish the change, oxygen is utilized, and, as a result of the change, carbon dioxide, lactic acid, and other substances are produced. During the process heat is generated and must be dissipated. Because metabolism is a continuous process, a constant demand is made upon the lungs, heart, blood vessels, and other organs to maintain an adequate supply of oxygen, an adequate supply of energy foods, and other necessary conditions. This demand fluctuates as the amount and intensity of activity or work fluctuates.

When the physiological changes keep pace with the demands, the work continues at a high level of effectiveness as measured by amount, accuracy, wastage, and similar signs. When the work exceeds the normal capacity of the organs, then various disturbances may result. For example, when insufficient oxygen is present—a condition known as oxygen debt—reconversion of lactic acid into glycogen is slowed up, and the accumulation of excessive amounts of lactic acid then has a deleterious effect upon muscular response.

With continuous work, certain changes in the coordination among muscles occur. Movements become more effective when the muscular involvement is reduced to a minimum, and the essential muscles function with ease and smoothness. Continuous work, with its attendant physiological changes, affects the innervation of the muscles involved in a given reaction, bringing into play nonessential muscles. This phenomenon is a common experience in tasks involving a prolonged contraction in a limited group of muscles as, for example, holding open a heavy box lid. As the muscles first used get tired, other adjacent muscle groups are called into play, and eventually arm, back, and leg muscles are straining in the attempt to hold open the lid. The energy cost at this point is much larger than in the beginning owing to the use of muscles ordinarily nonessential in nature, and the coordination and precision of responding members are greatly reduced.

Production-criterion Concomitants.—Many different production criteria have been studied in connection with continuous work. Probably the most important three are the time required to accomplish a given unit of work, the number of units of work performed in a given time, and the quality or excellence of the units of work as evaluated against some standard. It should be obvious from the preceding discussions that the relative variations in these criteria when applied on the same job are not perfectly consistent, although a positive correlation between them is usually found. Much of the scientific investigation of continuous human work has utilized the amount-of-work-accomplished criterion, and the most complete descriptions of variations tc be expected from prolonged work involve this criterion.

Amount of output, when graphed against time at work, gives what is called the "curve of work." Fluctuations in this curve have received rather comprehensive study in the psychological laboratory. A few of the characteristics of the curve will now be discussed.

Warming Up.—As an individual begins to work he shows, in many instances, a gradual increase in the rate of work. To state it in everyday terms, he starts out cold and warms to his task. This warming-up effect is, in part, physiologically determined. The capacity of the muscles and nerves to perform their functions increases somewhat as the activity is continued. Athletes always do some exercising before they enter a contest. No baseball manager would risk sending in a relief pitcher unless he had warmed up by throwing the ball for a period of time.

Although warming up has a physiological basis, it also seems to involve a change in attitude and attention on the part of the worker.[9] It takes him some time to direct his thoughts to his work and away from other matters with which he was concerned just before he began to work. As he becomes more and more absorbed in his work and focuses his attention upon it, an increase in output results. The phenomenon of warming up is not seen in all curves of work. It is most likely to occur when the task is discontinuous with frequent short alternations of work and rest.[10]

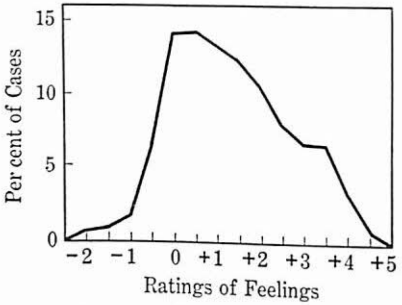
General Decrement.—In most situations, as the individual continues to work, both the speed and quality of his work gradually diminish.[11] Barmack, for example, had subjects perform arithmetical problems for a period of 4 hr.[12] Speed of work was indicated by the number of problems attempted. By the end of the work period the number of problems completed per unit of time had decreased 17 per cent, and the number of errors had doubled. Of course many factors will be present to change this picture, so that in some instances there may be no significant changes in speed and quality of work during a continuous application of several hours.

Spurts.—The general downward course of the work curve is occasionally interrupted by what appear to be significant increases in speed of work. Although in many instances these spurts cannot be attributed to any known factors, under certain circumstances they occur with marked consistency. With workers paid on a piece-rate basis, it is not uncommon to find an end spurt in speed of work during the last periods of the day's work. Again, after rest pauses there are likely to be spurts, and compensatory spurts are found after other types of interruption.[13]

Increased Variability.—In some cases, as the individual continues to work, speed of performance shows an increased variability.[14] During the continued activity on a given task, the individual may work in a series of spurts and stops, alternately increasing and decreasing his speed of work. In part this may be due to a need for rest or recuperation from the effects of the continuous activity. It has been found under certain circumstances that an individual engaged in continuous activity may show very short periods of complete blockage when no work is performed.[15] These periods are so short that the worker may be completely unaware of them. It cannot be concluded therefore that all interruptions in work are voluntary on the part of the worker.

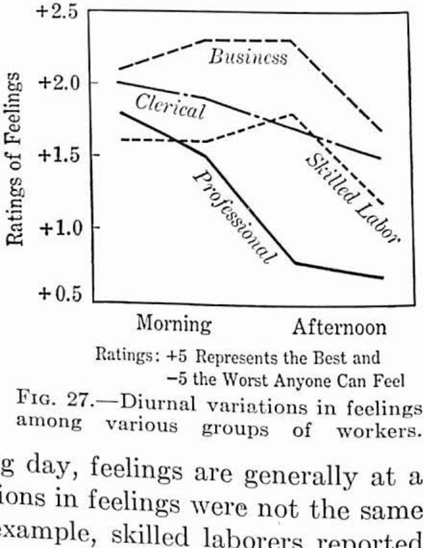
Mental Concomitants.—Changes in feelings of tiredness have generally been given less attention than changes in product criteria. This does not mean, however, that they are less important, but rather that up to the present little success has been achieved in accurately measuring them. It is important to note that there are wide individual differences in feelings. Cason obtained reports relative to their feelings from a large number of persons in various walks of life.[16] Each person rated how he felt during different periods of the day, using +5 to represent the best feeling and −5 to represent the worst state of feeling, with other numbers representing intermediate feelings. Although, to be sure, the feelings reported were general feelings, it seems likely that they were to a considerable extent feelings of weariness. The distribution of the individual averages of these daily feelings is shown in Fig. 26.

Cason also considered daily variations in feelings for different occupational groups.[17] His results, shown in Fig. 27, indicate that, during the last hours of the working day, feelings are generally at a low ebb. He found that the variations in feelings were not the same for all occupational groups. For example, skilled laborers reported no reduction in feelings until the end of the day, whereas for professional workers there was a steep downward trend throughout the day. The important consideration here is that significant differences in feelings of tiredness are to be expected from different types of work.



Ratings: +5 Represents the Best and −5 the Worst Anyone Can Feel

FIG. 26.—Distribution of average daily ratings of feelings of 899 persons in various walks of life.



Ratings: +5 Represents the Best and −5 the Worst Anyone Can Feel

FIG. 27.—Diurnal variations in feelings among various groups of workers.

A number of laboratory experiments have demonstrated that feelings of tiredness increase with continuous activity.[18] Introduction of a rest pause has been found to reduce the extent of such feelings. In the industrial situation, of course, work is seldom continuous. If systematically scheduled rest pauses are not provided, the worker generally takes them as he sees fit, and he knows that management expects him to do so. Thus with interrupted activity, as it is found in industry, feelings of tiredness probably do not increase steadily throughout the day.

It will be pointed out in the next chapter that an increase in the length of the work period produces a decrease in the speed of work. Results obtained by Barmack, however, indicate that when individuals are performing continuous mental work, subjective feelings of tiredness increase at the same rate regardless of the length of the work period.[19] Although the subjects in Barmack's experiment reported greater feelings of tiredness after longer (4-hr.) than shorter (1-hr.) periods of work, at the end of the first hour those subjects who had only 1 hr. to work reported feelings of tiredness no greater than those who had 4 hr. to work. This finding was true despite the fact that the speed of work of the 1-hr. group was greater than that of the 4-hr. group.

The chief difficulty in studying the feelings of tiredness that are concomitant with continuous work lies in the crudity of the methods of measurement that have thus far been devised. As can be seen from the investigations cited above, only a rough approximation to measurement can be claimed. Undoubtedly with more refined techniques for measuring varying degrees or amounts of tiredness, many important findings will be forthcoming.

In addition to producing increased feelings of tiredness, continuous activity results in certain other changes perhaps best termed *changes in attitude.*[20] Workers who have performed a task for an extended period of time may change their critical attitude toward the work. Standards of judgment are revised. The speed or quality of performance now accepted as satisfactory would be thought inadequate by the same worker when he is fresh at the task. Tolerances are broadened, and the level of achievement accepted as necessary and satisfactory is lowered. For example, a pilot starting out on a flight scheduled for 5,000 ft. altitude will make every effort to stay within 100 ft. of that altitude. After several hours of flying, however, he will consider any altitude between 4,500 and 5,500 ft. as a satisfactory approximation of 5,000 ft.

THE MEANING OF EFFECTIVE WORK

In previous discussions the concepts of efficiency and fatigue have been shown to be inadequate and ambiguous. Effectiveness of the work of human beings therefore cannot be gauged in terms of either of these concepts. A further difficulty with the use of efficiency and fatigue in evaluating the effectiveness of work—and a difficulty of utmost importance in industry today—is that these concepts are far too narrow and restrictive in scope. They assume that the worker is solely a producing machine, and by implication at least they not only deny the importance of other relations between the individual and his job but also disregard many of the qualities of the worker as a human being, which should be included in any attempt to evaluate his contribution.

Some Criteria for Evaluating the Effectiveness of Work.—The life of the worker on his job is not independent of, and unaffected by, his life away from work, nor is his outside life unaffected by his activities on the job. Both are closely related and knitted together. Criteria of the effective contributions of the worker must consider all aspects of the individual, not only as he functions as a worker on the job but also as he functions as a member of his family and as a citizen of his community. In evaluating the effectiveness of human work it is necessary to establish the standards on a very wide base. Attention must be given to every criterion by which work can be judged as effective or noneffective. The following outline attempts to list the major and more obvious kinds of factors that should be taken into consideration in evaluating the effectiveness of work.

A. Economic considerations
    1. Productivity
        a. Amount
        b. Quality
    2. Wastage, errors, damage
    3. Lost time
    4. Financial aspects
        a. Labor costs
        b. Compensation for unemployment and disability
B. Physiological and physical considerations
    1. Physiological and physical demands on the individual
    2. Accidents and injury
    3. Short-term illnesses
    4. Permanent effects on health
C. Mental considerations
    1. Feelings of tiredness
    2. Feelings of effort
    3. Monotony
    4. Satisfaction with work, job pride
    5. Personality adjustments
D. Social considerations
    1. Family adjustment and happiness
    2. Level of standard of living
    3. Cultural achievements
    4. Social status
    5. Crime and juvenile delinquency

The Complex Nature of Evaluation of the Effectiveness of Work.—It is apparent that there are so many phases of the worker's economic, mental, and social lives that any list such as the foregoing must necessarily be incomplete. The point is that a particular method or condition of work can be evaluated in a variety of different ways. It cannot be assumed that, because one method or condition is superior to another in certain respects, it is therefore more effective in all other respects. Furthermore it cannot be assumed that certain types of indices are necessarily more important than other types. In most cases, different indices of effectiveness cannot be reduced to comparable bases. It cannot be said, for example, that a reduction in effectiveness in family adjustment, as indicated by an increase in divorce rate of 5 per cent and of juvenile delinquency of 5 per cent, is more or less important than a 10 per cent increase in number of units of work produced. It would be difficult to defend the position that benefits in any one respect will invariably counterbalance costs or demands in another respect.

Another factor requiring attention in evaluating any new work method or procedure is the cumulative effects it may have on the worker. Most of the time the sights of management are set upon immediate increase in production, and very frequently the worker's goals revolve around immediate improvement of his status; thus both are failing to evaluate in terms of the span of productive years that is available, and which limits what can be accomplished by both management and worker alike. The conservation of human productive power requires evaluation of energy expenditure over the years of worker productivity and not for a given day or week of work. Workers must utilize their energy not only to accomplish the tasks of the day but to continue an effective productivity on the job over the span of years generally considered as years of usefulness. Furthermore they must utilize their energy not solely for achievements on the job but also for accomplishing the tasks of all other phases considered necessary for a well-rounded and balanced life. On the other hand the worker is obligated to his employer to the extent of not dissipating his energies in off-the-job activities to the point that his effectiveness on the job is lowered. This obligation, likewise, must be viewed over the longer period of productive usefulness and not restricted to day-by-day effects.

The Equation of Industrial Production.—From the early days of industry up to the present time many attempts have been made to set up an equation to represent the relation between manufacturing costs,

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on the one hand, and returns, on the other. Gradually this equation has become more and more complex and involved as the special phases of production have developed and as the human phases of production have become more apparent. Early equations stressed the profit motive. A representative statement is:

Capital + materials + wages + overhead = amount + quality + profits

Later the contribution to the worker was considered as a legitimate result of production, and the statement was changed to:

Capital + materials + labor + overhead = amount + quality + profits + wages

Recent trends now point to further complications of the equation.

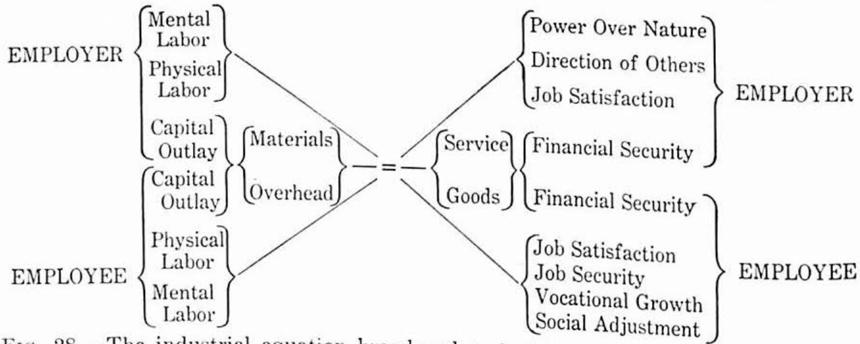

FIG. 28.—The industrial equation broadened to include psychological, physical, and economic factors for both employer and employee.

Both the employer and employee must appear on both sides of the equation, as both contribute to production and receive rewards from this production. The contribution and rewards, however, cannot be represented as dollar-and-cents values. It therefore is going to be impossible to balance the equation in any mathematical sense. The equation, however, must be balanced if industry is to achieve stability and make progress as increasing demands are made upon it. The future therefore will see intensive efforts directed toward a study of the human values involved in production in order that they, together with the material phases, may be brought into balance. Only in this way may a stable economy be maintained.

No one can predict what the equation of the future will be, but it will very likely contain most of the factors included in the equation represented in Fig. 28. On the left side of the equation the employer's contribution in the form of capital outlay and labor must be represented. Capital, in part, is transformed into materials and overhead.

The employee's contribution may also involve capital, and it must always include labor. The labor must be accepted as having definite physiological tolerance limits in strength, endurance, speed, coordination, and other characteristics. The equation must be expanded to include the psychological input of the employee, a phase that has always been present as part of his contribution but never given adequate consideration. Under this can be included feelings of effort and tiredness, boredom, worry and anxiety about the job, mental work involved in preparing for the job tasks, etc. The employer's contribution in the form of labor must likewise be considered to be twofold, physical work and mental work, the latter forming a greater proportion of the total contribution than in the case of the employee.

On the right side of the equation there again must be introduced psychological factors that have received insufficient attention in the past. For the employee there must be financial returns, as always, but these no longer can be considered as just plain wages. There must be financial returns that will provide for a decent standard of living, security for current emergencies, and security for old age. In addition, part of the return for his labor should be in terms of job satisfaction, of enjoyment from achievement and progress, of potential vocational growth, and similar psychological values.

A similar analysis must be made for the employer. He has always had to take the risk of failure and endure the anxiety and worry attendant upon it. He therefore must receive some compensation in other ways than through dividends and stock. As with the employee there is job pride and satisfaction. Two other psychological values that have played important roles in the employer's compensation are the satisfaction gained from overcoming obstacles of the environment and harnessing nature's forces, and the satisfaction of providing employment and supplying direction and supervision for large numbers of his fellows. Power over nature can still be encouraged to the utmost and probably will offer no serious social problems. Extension of control over fellows has many social implications of importance and will be a source of many problems. The solving of these problems is going to be one of the most difficult in the whole equation.

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CHAPTER X

CONDITIONS OF WORK AND PRODUCTIVITY

In previous chapters it was pointed out that measures of productivity are only one means of evaluating the effectiveness of work. Productivity is important principally because of economic considerations. It is to be remembered, however, that there are mental and social aspects of the effectiveness of work that are not classifiable as economic. Furthermore it cannot be said that the economic considerations are more or less important than the mental or the social considerations, since all three are interdependent and closely knit together.

DEFINITION OF PRODUCTIVITY

Output as a Measure of Productivity.—As has been pointed out several times earlier, output has two equally important aspects: amount and quality. These must be considered separately since they may vary independently or in an inverse manner. Under certain circumstances it has been found that as speed of work is increased quality is reduced. High output of poor quality is not a substitute for lower output of high quality. Indeed, just as there are differences between different workers or different conditions of work with respect to quantity of output, so there are similar differences with respect to quality of output. Nevertheless, as will be apparent from the following discussion of pertinent investigations, little attention has been given to quality as a measure of productivity. Different methods of work are evaluated almost solely in terms of amount. There appears to be a general assumption that all production is satisfactory in terms of quality, since in most instances the work passes a final inspection. But it is to be noted that standards of what is considered satisfactory quality may vary from organization to organization, and even within the same organization from time to time. Furthermore, even though the work passes the immediate arbitrary standard established, there may be variations in quality above that standard which will reflect differences in worker proficiency.

Lost Time as a Measure of Productivity.—In studying the effects of conditions of work upon output the common procedure is to compare changes in average output per unit of time with changes in conditions of work. In computing the averages the total output for a given period is divided by the man-days or man-hours worked. Such a procedure is satisfactory if one desires to study only the speed with which the men work. Under some circumstances, however, a given condition of work might not have a particularly adverse effect upon speed of work but might affect lost time. Thus, although the output of the employees who are working may remain practically unchanged, total or long-term output might be considerably reduced or improved due to an increase or reduction in time lost from the job. For example, installation of an air-conditioning unit might increase the comfort of the individual employee so that he can work faster, but, if the sudden change in temperature experienced upon entering and leaving the cooled room gives him a cold and forces him to stay away from his job for a day or so, total output will suffer. Furthermore a succession of these colds may easily reduce the vitality of the individual so that a more serious illness develops. The new condition of work therefore may be said to have an adverse effect upon output, to say nothing of the discomfort it produces in the employee, or of the economic loss that may be incurred either by him or his employer.

There are, of course, many causes of lost time, illness being only one. Strenuous work for too long periods, low worker motivation and morale, maladjustments in the home, and other similar factors will cause employees to stay away from their jobs. The analysis of such causes may be very revealing, but the end result is the same—lowered productivity.

The amount of lost time ordinarily is not equally distributed among a group of workers. Most persons lose little or no time, whereas a very few workers lose a great deal. For example, among groups of factory workers Vernon found that about half of the lost time was due to one-sixth of the workers, and 80 per cent of it was due to one-third of them.[1] By and large it appears that most of the lost time can be attributed to a relatively small proportion of the employees.

DIURNAL CHANGES IN PRODUCTIVITY

In Fig. 29 are shown the rates of productivity on two different jobs, one in an 8-hr.-day plant and one in a 10-hr.-day plant.[2] It will be observed that the curves have quite similar general configurations. At the beginning of both the morning and afternoon work spells, speed of production gradually increases to a maximum and then rapidly falls off, with the over-all speed of work during the morning being somewhat greater than that of the afternoon. This finding, that some daily work curves have similar general shapes, has given rise to the notion that there is a "typical" work curve. Although it is probably true that, if one examined and classified the daily work curves obtained from a large number of different jobs, many of the curves would be of the general shape depicted in Fig. 29, nevertheless the largest proportion would in one or more respects differ from this shape. Indeed, examination of Fig. 29 will indicate that only one of the four curves closely fits the description given above, that for dexterous handwork in the 10-hr. plant. The "typical" daily work curve therefore cannot be taken to be descriptive of the curves that would be found for most jobs. It is typical only in the sense that it is similar to more of the obtained curves than is any other shape of curve.

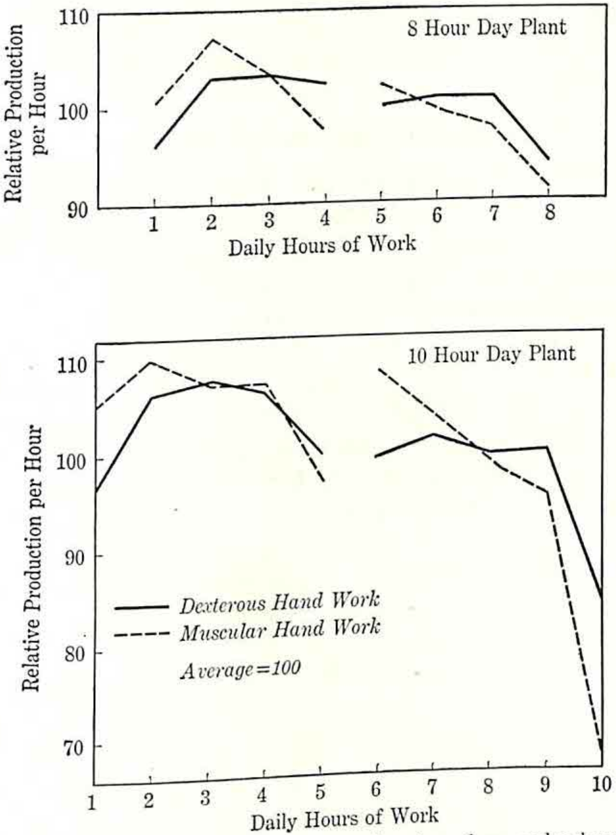

FIG. 29.—Daily curves of work for dexterous handwork and muscular handwork in an 8-hr.-day plant and in a 10-hr.-day plant.

It is apparent therefore that the daily work curve will vary markedly with the nature of the job. Generally, the more physically strenuous the work and the longer the work day, the greater will be the general reduction in speed of work from the beginning to the end of the day. Also with workers on the night shift there is likely to be a greater loss in speed of work from the beginning to the end of the work period than with workers on the day shift. In certain instances, where speed of work is controlled either voluntarily or because of machine speeds and supply of materials, the daily work curve may appear as a horizontal straight line.

LENGTH OF THE WORK PERIOD

Length of the Work Period and Speed of Production.—During national crises, such as war, it has been common practice to lengthen the work day to as much as 14 hr. in anticipation of greater production of manufactured goods to satisfy increased demands. The fallacy of the general application of such procedures was dramatically revealed in England during the First World War. In a munitions plant, when the working week was reduced from 66 to 48.6 hr. (a reduction of 26 per cent) hourly output was increased by 68 per cent and total output for the week by 15 per cent.[3] This instance could be multiplied many times.[4] Typical results obtained in four factory operations are shown in Table 58.[5] These results illustrate a common finding that heavy work benefits more from a reduction in hours than does light work. In addition it will be seen that the more the work is handwork and the less it involves machines the greater will be the benefits resulting from shortening the length of the work period.

Optimal Length of the Work Period.—No final conclusion can be drawn at the present time as to the optimal length of the work day or the work week. Much more research needs to be done on these problems. It seems probable that the optimal period will vary considerably with the nature of the work and with the nature of the worker. In any particular employment situation therefore this problem will have to be solved by a systematic investigation. In such an investigation one important feature of changing the length of the work period should be noted. Gains in output resulting from reduced working time will not necessarily be immediately manifest. Some of the results summarized by Vernon are shown in Table 59.[6] For operations that are relatively light and are chiefly done by hand, the time to reach a final level of output may be relatively short, as in the case of boring top caps, which required only 3 weeks to reach an

TABLE 58.—THE RELATIONSHIP BETWEEN HOURS OF WORK AND OUTPUT IN CERTAIN FACTORY OCCUPATIONS

Length of work period		Relative output	
Hours per week	Relative length	Per hour	Per week
Men sizing fuse bodies: heavy work, completely hand			
66.7	100	100	100
60.2	90	120	105
55.5	83	137	119
Women turning fuse bodies: heavy work, chiefly hand, partially machine			
74.5	100	100	100
63.5	85	121	100
55.3	75	156	113
Women milling a screw head: chiefly machine, partially hand			
71.8	100	100	100
64.6	90	121	102
57.3	80	133	97
Youths boring top caps: almost wholly machine			
76.8	100	100	100
60.1	78	121	93

TABLE 59.—TIME TO REACH MAXIMAL OUTPUT AFTER A REDUCTION IN THE LENGTH OF HOURS OF WORK

Job	Change in hours	Time to reach maximal output, weeks	Increase in output per hr., per cent
Women turning fuse bodies..	63.5 to 55.3 per week	31	29
Women turning fuse bodies..	74.5 to 63.5 per week	17	21
Men sizing fuse bodies.......	60.2 to 55.5 per week	48	16
Men sizing fuse bodies.......	66.7 to 60.2 per week	9	29
Youths boring top caps......	76.8 to 60.1 per week	3	21
Open-hearth furnacemen.....	12 to 8 per day	56	18
Tin-plate millmen...........	8 to 6 per day	8	11

increase in output of 21 per cent. On the other hand, with heavy manual work the time may be considerably longer, as illustrated in the case of open-hearth furnacemen, who took over a year to reach an increased output of 18 per cent following a reduction in the length of the working day.

Basis of Time Lag in Increase in Production Following Reduction in Work Period.—The decreased output during a longer working period cannot be attributed to a voluntary slowing down on the part of the employees as a protest against the longer working time, since the same type of results has been obtained in the psychological laboratory with highly motivated subjects working short periods of time. The worker adjusts his speed of work to the magnitude of the task set for him, slowing up to conserve his energy for a long or arduous task and speeding up when he knows continued expenditure will not be demanded. This adjustment is the same as that made by the track runner. The miler, for example, who started off at the rate of the 100-yard-dash man would never complete his race.

Poffenberger reports that, when subjects were instructed to squeeze a dynamometer as hard as possible, they averaged 52 kg. on the first squeeze when they were informed that they would have to do the task fifteen times, and 68 kg. when they were informed that they had to do the task only once.[7] Similarly, Bills and Brown had subjects do arithmetic problems for 1, 2, 5, and 10 min., and found that the shorter the time the subjects expected to work the greater was the output during the first minute of work.[8] These investigators also found that physical effort, as indicated by the pressure the subjects exerted on the pencil with which they wrote down their answers, was greater when anticipating the shorter rather than the longer periods of time.

Very Short Periods of Work.—The conclusion should not be drawn from the findings discussed above that shortening the working time invariably results in increased speed of production. Rather, there appears to be an optimal length of working time, both longer and shorter ones being less effective. Wyatt found that when the working week of cotton weavers was reduced from 5½ to 4 days, the average hourly output fell 6 per cent; consequently, total weekly output was considerably reduced.[9] Similar results are reported by Miles and Angles for a box-manufacturing plant.[10]

The fact that very short working hours do not bring about greater output is due in part to the so-called "warming-up effect," which manifests itself in terms of a lower speed of operation during the initial period of adapting to the work. The reduced output in the first hour of work will be more important in a 5-hr. working day than in a 9-hr. one, since in the former 1 hr. of work constitutes a greater proportion of the working day (20 per cent) than it does in the latter (11 per cent).

Thus a very short working day will not be so effective as a long one, owing to the proportion of the working time required by the worker to warm up to his maximum proficiency.

When the worker first comes on the job in the morning, and after the lunch period, he will lose a certain amount of time adjusting the machines and equipment. Before the end of the working spell he will stop work that directly issues in production to perform certain other tasks. This lost time ordinarily is discounted, but it might involve a fair proportion of the total working time. For example, Vernon found that a group of factory workers employed on a 10-hr. day, took on the average, 14.0 min. to start work in the morning and 12.3 min. to start in the afternoon.[11] They stopped 1.3 min. before quitting time in the morning and 9.3 min. before final quitting time in the afternoon. Thus a total of 37.1 min., or about 6 per cent of the total working time was not devoted to actual production. With many jobs the other kind of work done by the employees during these periods is quite necessary. It seems unlikely therefore that it could be reduced to any great extent. Therefore a greater proportion of a shorter working day will be consumed by these activities not reflected in production than in a longer day. This factor, in addition to the warming-up effect, contributes to making output on very short working days inferior to that of somewhat longer ones.

Lost Time and Length of the Work Period.—In Table 60 data are presented relative to the relationship between the length of the work week and the amount of lost time among factory workers.[12] It is

TABLE 60.—THE RELATIONSHIP BETWEEN LENGTH OF THE WORK WEEK AND AMOUNT OF LOST TIME AMONG FACTORY WORKERS

Length of the work week		Lost time	
Hours	Relative time	Per cent	Relative time
		Men	
63	100	7.0	100
62	98	5.7	81
54	85	4.0	57
		Women	
62	100	6.4	100
54	87	4.3	67
44	71	3.1	48

apparent from this table that reducing the length of the working week produced a disproportionately greater reduction in amount of lost time. Thus with men factory workers the amount of lost time fell 43 per cent when the length of the work week was reduced by 15 per cent. Under favorable conditions, therefore, when the length of the work period is shortened, lost time might be expected to fall. Under many circumstances it would appear that the expected reduction in amount of production from shortening the hours of work is compensated for by the increased production effected by greater numbers of employees reporting for work. Further study of the relationship between these two factors should be made.

REST PAUSES

Voluntary Rest Pauses.—The employee carrying on his work at the rate usually desired in business and industry cannot continue that rate without periods of rest. When systematic rest pauses are not set for him, he necessarily will have to take them voluntarily. Factors related to the length of these voluntary rest pauses have been the subject of considerable study. Rest pauses appear to be a function of the nature of the work, being somewhat longer with heavy work than with light work. This is illustrated by some of the findings of Vernon, Bedford, and Warner which are presented in Table 61.[13] These investigators also found that voluntary rest pauses are not so marked with piece-rate workers as with those paid on a time-rate basis.

Other investigations have shown that the duration of rest pauses is a function of the length of the work day. With a group of women factory workers, voluntary rest pauses were 28 per cent less when an 8-hr. day was worked than when the day was 10-hr.[14] The voluntary rest pauses of silk winders, coil winders, and lathe operators were found to be 40 per cent less on the part of those working a 41-hr. week than for those working a 49-hr. week.[15] In a tin-plate plant the voluntary rest pauses were 18 per cent less when the men worked a 6-hr. day than when they worked an 8-hr. day.[16] These findings suggest that a change from a very long working day to one of moderate length will produce a reduction in voluntary rest pauses disproportionately greater than the reduction in the working hours, whereas a change from a day of moderate length to a very short day, although reducing the length of voluntary rest pauses, will not produce a decrease proportionate to the reduction in working time. The differences in the proportions of time taken for voluntary rest pauses in very

TABLE 61.—THE PROPORTION OF TIME CONSUMED BY VOLUNTARY REST PAUSES IN SEVERAL OCCUPATIONS

Occupation	Operation	Time per hour in voluntary rest, per cent
Agriculture	Horse plowing	24
	Harrowing	14
	Rolling	14
Roadmaking	Picking and shoveling sand	21
	Picking up road surface	20
	Shoveling earth into wagons	19
	Shoveling sand into tubs	17
	Shoveling earth and wheeling barrows	13
Building	Bricklayer's laborers	19
Dock labor	Unloading timber	20
	Unloading sacks	18
Boot-and shoe-making	Consolidated lasting	6
	Pulling over	6
	Leveling	5
Rolling tin plates	Furnacemen	12
	First helpers	12
	Rollermen	12
	Behinders	12
	Second helpers	8
	Doublers	8

long and very short work days, as compared with working days of moderate length, may partially account for the reduced output characteristic of the longer and shorter work periods.

Systematically Scheduled Rest Pauses.—Vernon, Bedford, and Warner have pointed out that the rest pauses voluntarily taken by workers tend to have a certain regularity. Some of their observations on individual workers are summarized in Table 62.[17] It will be noted in the table that the regularity of rest pauses is in terms of both frequency and length. A worker tends to take about the same number of rest pauses in equal successive time intervals, and the length of the pauses is relatively constant. These findings indicate that systematically scheduled rest pauses would be of considerable value, and, indeed, many studies have shown them to be so.

In a boot and shoe factory, under an older system of work, two

TABLE 62.—THE REGULARITY OF VOLUNTARY REST PAUSES OF INDIVIDUAL WORKMEN IN TERMS OF FREQUENCY AND LENGTH

Worker and job	No. of rest pauses in successive ½-hr. periods				Length of rest pause	
	1	2	3	4	Average, min.	Average deviation, min.
A. Picking road surface	6	6	5	5	0.8	0.3
B. Picking road surface	5	4	5	5	0.9	0.3
C. Shoveling earth	5	5	7	4	0.8	0.3
D. Shoveling earth	6	5	5	4	0.7	0.2
E. Picking and shoveling	7	7	7	9	0.6	0.1
F. Picking and shoveling	8	9	7	9	0.6	0.2

girls tended each machine and worked at it constantly.[18] Under a newer system a team of three girls was assigned to each machine and worked in shifts, so that two girls at a time tended the machine while the third girl rested. Each girl worked 40 min. per hr. and rested 20 min. This change in schedule resulted in an increase in weekly output of 44 per cent, in spite of the fact that the total amount of time each girl worked was reduced by one-third. In addition the girls reported that they felt less tired under the new schedule.

In an investigation of girls employed in labeling, the introduction of a 10-min. rest period in the middle of the morning was found to increase hourly production 20 per cent, whereas working time was reduced only 2 per cent.[19] McGehee and Owen found that the introduction of a 12-min. rest pause in the middle of the morning and a similar pause in the middle of the afternoon increased the output of comptometer operators 29 per cent and decreased the length of voluntary rest pauses by 60 per cent.[20] This study is a valuable one because it shows that rest pauses in an office situation may prove as beneficial as rest pauses in factory or manual work situations. Since the time devoted for rest was added on at the end of the day, the increase in output cannot be ascribed to a shortened working day but rather must be attributed to the periods of rest themselves. The responses of the operators on a questionnaire dealing with working conditions indicated that the workers were not very favorably disposed toward the systematically scheduled rest pauses. Their reactions apparently were not due to the extra time added to the work day as much as to the crowded conditions of the rest rooms during the pauses.

Factors Determining the Efficacy of Rest Pauses.—The efficacy of rest pauses will be a function of the time at which they are introduced and of their length.[21] The evidence indicates that they should be introduced when output is at a maximum, just before production begins to fall. Rest pauses introduced either earlier or later are not so effective in maintaining a high level of productivity. The optimal time between rest pauses naturally varies from one job to another and will have to be determined separately for each. This will also be true insofar as the optimal length of the rest pause is concerned. The effectiveness of a rest pause will not be proportional to its length; rather there will be an optimal time. If the pause is too brief it will simply interrupt the worker and not help in overcoming work decrement. On the other hand, if it is too long the worker will have to go through a fairly long warming-up period when work is resumed. In either case, output may even show a decline.

There is some evidence that less effective workers benefit more from rest pauses than do the better ones.[22] This is due in part to the fact that the better workers adopt more effective methods of work that are not so demanding upon them. For example, Farmer found that among workers engaged in roughing spoons the better workers used many fewer movements per item of work than did the poorer workers.[23] With 26 workers he found a coefficient of correlation of 0.89 between the average time needed to rough a spoon and the average number of movements made per spoon.

When the work is purely automatic, rest pauses are less effective than when the work involves considerable concentration.[24] This is to be expected, since during automatic work the employee is free to carry on conversations, daydream, and engage in similar activities that will reduce the monotonous character of the job.

It is ordinarily believed that the beneficial effects of rest pauses are purely physiological. However, as Pennock suggests, the resulting increase in output can be attributed in part to a change in the attitude of the employees toward the working situation.[25] He reports this finding from a study of a group of girls assembling telephone relays who were subjected to a series of different conditions of work, among which were variations in the position and length of rest pauses. The production of these workers continued to increase regardless of the nature of the working conditions that were introduced. Even when rest pauses were completely eliminated, output continued to increase. During the experimental period, which lasted some 2 years, there was a noticeable improvement in the attitude of the girls toward the management. The relationship of confidence and friendliness that developed toward management seems to account for the continuous rise in production. Another indication of the part played by attitude is found in Wyatt's report that workers actually anticipate rest pauses by showing an increased rate of work immediately preceding a rest pause.[26]

SHIFT WORK

One solution to the problem of obtaining maximal production with the minimum of overhead expense is to have employees work on successive shifts. There has been much discussion of the advantages and disadvantages of the shift system, and, although there are a number of scattered investigations of specific aspects of the problem, most conclusions have been reached without reference to facts or figures. It was not until 1934, when Vernon published a summary of the problems and statistical findings, that any adequate analysis was available.[27]

The confusion in the field can be illustrated by reference to a report of a committee of the Home Office of Great Britain made in 1920.[28] Witnesses to the committee were drawn from employees, organized labor representatives, employers' organizations, physicians, social workers, and other similar groups. Although some of the witnesses said that shift work disturbed meals and hours of sleep, others denied it. The advantages of club life and evening classes were claimed to be interfered with by shift work, but it was pointed out that even under the most favorable conditions only a very small proportion of industrial workers took part in such activities. It was said that shift work interfered with the social life of the home, but in many cases this was found to be untrue.

Obviously, conclusions based on such opinions cannot be accepted. Knowledge concerning the effects of shift work must be based upon sound investigation and not opinion. Unfortunately, most of the findings either deal only with the two-shift system, where employees working on the shift put in fewer hours than day workers, or merely compare day work with night work. In actual practice several different types of shift systems are in operation.

Output.—Vernon has summarized some of the findings relative to the effects of the two-shift system on output.[29] These results, given in Table 63, indicate that the two-shift system, with its shorter working week, results in an hourly output that is considerably higher than that of the single shift, whereas weekly output is only slightly reduced. Clearly the combined output of both shifts on the two-shift system is vastly superior to that of the single day shift.

TABLE 63.—A COMPARISON OF THE OUTPUT OF WORKERS ON A TWO-SHIFT SYSTEM WITH THAT OF DAY WORKERS

Type of work	Hours of work per week		Relative output of two-shift workers taking output of day workers as 100	
	Shift	Day	Hourly output	Weekly output
Coil winding	40¾	47	104	90
Coil winding	40¾	47	107	94
Coil winding	40¾	47	100	87
Engraving	40¾	47	107	92
Wire drawing	43½	47	98	90
Lathe operation	41¼	49 55	123	104 92
Lathe operation	41¼	49 55	118	100 89
Cable insulating	41½	49	135	113
Cable insulating	41½	49	125	104
Average	41¼	49¼	113	96

The evidence in which day shift is compared with night shift in factory and manual work runs counter to what is ordinarily expected. Vernon has reviewed the studies of production on such jobs during the day and night shifts, and the findings are summarized in Table 64.[30] It will be observed that, when the workers are shifted from day to night work at regular intervals, output on the night shift is exactly the same as that on the day shift. The sex of the workers is not a relevant factor, since the production of women workers is maintained at a level on the night shift as high as that of men. Furthermore it appears that the nature of the work is not a determining factor. The work can be of a strenuous manual sort, as charging blast furnaces; highly repetitive work, as in the cartridge-case operations; completely handwork, as in sizing fuse bodies; or almost wholly machine work, as in boring top caps.

The data in Table 64 also indicate that when workers are kept continuously on the night shift their output is significantly reduced. This conclusion is supported by studies in which the output of a group of workers on a continuous shift is compared with their output on a changing shift. Although the differences are not quite so striking, they are nevertheless in the same direction. With a group of women engaged in various cartridge operations, Vernon found that their hourly output for 4 weeks on a continuous day shift was 1 per cent less than

Table 64.—A Comparison of Output on the Night Shift with That on the Day Shift
(Output of the day shift = 100)

Type of worker and work	Hourly output of night shift	Frequency of change from day to night shift
Cases with periodic changes from day to night shifts		
Women, cartridge-case operations	101	Weekly; 52 hr. day shift, 55 hr. night shift
Women, cartridge-case, operations	99	Same as above
Women, cartridge opr., second draw	102	Weekly; 51.7 hr day shift, 55.9 hr. night
Women, cartridge opr., head trim	98	Same as above
Women, cartridge opr., second cutoff	100	Same as above
Women, cartridge opr., reaming	102	Same as above
Women, cartridge operations	95	Weekly
Men, 6-in.-shell operations	104	Every 4 weeks
Men, 9.2-in.-shell operations	101	Weekly
Men, hand-charged blast furnace	99	Weekly
Women, turning fuse bodies	109	Every 2 weeks
Men, sizing fuse bodies	103	Every 2 weeks
Women, milling a screw thread	103	Every 2 weeks
Youths, boring top caps	99	Every 2 weeks
Average	101	
Cases with continuous night work compared with continuous day work		
Men, boring powder chambers	90	
Men, finishing, turning, 3-in. shells	98	
Men, rough turning 3-in. shells	94	
Women, cartridge opr., during winter	83	
Women, cartridge opr., during summer	88	
Women, bullet opr., during winter	90	
Women, bullet opr., during summer	100	
Average	92	

their output on a previous 6-week period and a subsequent 10-week period, when they were on a changing shift.[31] The hourly output of another group of cartridge workers during a 5-week period on a continuous night shift was found to be 4 per cent less than their output on previous and subsequent weeks when they were on a changing shift.

Working on the night shift seems to affect production on the day shift. As Vernon has suggested, any detrimental effects of night work may accumulate toward the end of that shift and reduce the output at the beginning of the day shift.[32] As evidence for this hypothesis he offers data relative to the output of munitions workers who changed over from the day to the night shift every 2 weeks. During the first week on the night shift hourly output was at its highest, being 140. This fell to 137 during the second week of night work. During the following first week of day work output was 134, and during the second week it rose to 136.

Lost Time.—Vernon has compared both the voluntary and involuntary work stoppage of artificial silk workers, coil winders, and lathe operators, on a two-shift system with comparable groups of day workers.[33] The shift workers took voluntary rest pauses averaging 4.1 min. per hr. and involuntary pauses of 1.9 min.; the day workers took voluntary rest pauses of 6.8 min. per hr. and involuntary ones of 3.1 min. The higher hourly output of the shift workers therefore can be explained in part on the basis of less time spent in activities not reflected in production. The involuntary pauses are due to such activities as obtaining materials and adjusting materials. The fact that these activities are reduced on the shift system suggests that more effective methods of work were employed on this system.

Although Vernon found the hourly output of the later shift to be equal to that of the earlier one, a difference did appear in time lost from working.[34] Workers on the later shift took 63 per cent more time in involuntary and voluntary pauses than those on the earlier shift. Absences too were more common among the shift workers than among the day workers. Although there were about 6 per cent more instances of tardiness among the day workers, tardiness among shift workers was usually much more serious. Avoidable absences also are less frequent during the night shift than during the day shift. With munitions workers, for example, such absences were 30 per cent less frequent with the night shift than with the day shift.[35]

The effect of night work upon day work can be observed in lost time as well as in production. With women engaged in the light work of gauging and assembling fuse parts, where they changed shifts every 2 weeks it was found that lost time was at a minimum during the first week on the night shift, when it amounted to 5.9 per cent of the working time.[36] During the second week on the night shift it rose to 6.8 per cent. The following week, the first week on the day shift, lost time amounted to 8.4 per cent, and on the second week of this shift it fell to 7.4 per cent.

Sickness.—The available statistics indicate that neither the two-shift system nor night-shift work has any deleterious effect upon health. In an artificial silk mill, for example, it was found that the same proportion of workers on the two-shift system reported to the first-aid station for respiratory troubles, headaches, neuralgia, faintness, disorders of the digestive system, etc., as was found for day workers.[37] The effect of night work upon health cannot be ascertained in this direct manner due to a lack of information. However, with men employed at an engineering works where every other week they changed over from the day to the night shift, or vice versa, it was found there was about 60 per cent less time lost for unavoidable causes on the night shift than on the day shift.[38]

PHYSICAL CONDITIONS OF THE WORK ENVIRONMENT

Illumination.—That conditions of illumination are an important problem in industrial psychology is indicated by the fact that one survey of 21 industrial and office activities showed that the eyes were engaged in important work during 70 per cent of the working day.[39] Considerable evidence has been gathered that supports the validity of the following two important principles of effective illumination.[40]

1. The intensity of the illumination should be sufficient for the task.
2. The visual field should be as uniformly illuminated as possible with any bright spots placed as close as possible to the fixation point of the eyes.

Evidence that many industrial plants are inadequately illuminated comes from the fact that increasing the illumination produces increased output. Typical results obtained by Luckiesh and Moss are shown in Table 65.[41] Other investigations reveal a similar situation.[42] Although increases in intensity of illumination may be expected to produce increases in output, a point is reached beyond which further increases in illumination will not be profitable or bring about further benefits to the employee. This point will vary quite naturally with the particular work situation and the kind of work.

Ferree and Rand have shown that the intensity of illumination required for effective work not only varies with the work situation and type of work but also with the worker.[43] For example, they found that with younger workers a high level of visual acuity is achieved at 10 foot-candles of illumination, and further increases in intensity produce only negligible increases in acuity. With middle-aged workers, however, such an intensity is inadequate, and it is only with further increases that maximum acuity is reached. In the case of older workers a low level of acuity is characteristic of nearly all intensities, and intensities beyond 20 foot-candles do not appreciably increase visual acuity.

TABLE 65.—EFFECTS OF INCREASING THE INTENSITY OF ILLUMINATION UPON OUTPUT

Type of work	Old intensity, foot-candles	New intensity, foot-candles	Increase in production, per cent
Pulley finishing	0.4	4.8	35
Metal bearings	4.6	12.7	15
Steel machining	3.0	11.5	10
Carburetor assembly	2.1	12.3	12
Iron manufacturing	0.7	13.5	12
Buffing shell sockets	3.8	11.4	9
Letter sorting	3.6	8.0	4

Improved output cannot be expected to follow immediately upon changing conditions of illumination. The employees must be allowed time to adjust themselves to the new working conditions. In one case with key-punch operators, production showed no marked increase until about 2 months after the intensity of illumination was changed from 8 to 60 foot-candles, and errors showed no marked reduction until after about 4 months.[44] The apparent final level of output, an increase of about 55 per cent, and of accuracy, a reduction of about 70 per cent in errors, was not reached until 1½ years after the change was made. Although these times may be longer than usually is expected for a change in illumination to become manifest in output, the findings of this study emphasize the necessity for permitting the employees to work under a new situation for an adequate time interval before final evaluation of any change is made.

All the increase in output resulting from increased intensity of illumination cannot be attributed to increased visual acuity. In one investigation it was found that output was 8 per cent greater with work carried out purely by touch, when the subjects wore goggles equipped with frosted glass that permitted light to reach the eyes but prevented detailed vision, than when they worked in the dark.[45] Apparently light has a facilitating effect upon workers. These findings may be due to the decrease in feelings of tiredness and the increase in feelings of well-being of the workers, which have been reported under conditions of improved illumination.

The strong tendency of the eyes to fixate the brightest part of the visual field is evidence that the visual field should be uniformly illuminated. In actual practice it is next to impossible to have the total visual field absolutely uniform, because of the variation in reflective powers of different materials and colors. The solution therefore is to have any bright spots as close to the work as possible. In addition it is sometimes possible to have the illumination at the immediate work place greater than that in the surrounding work environment.

Ferree and Rand have studied conditions of illumination in relation to visual efficiency during reading.[46] These investigators consider the ratio of blurred to clear time as a measure of what they term visual efficiency. Daylight gives the most uniform illumination, indirect artificial illumination the next most uniform, semi-indirect the next, and direct the least uniform. The percentage loss in visual efficiency during reading found by Ferree and Rand for these four types of illuminating conditions is given in Table 66. It will be noted that reading in daylight produces the least loss in visual efficiency, indirect lighting produces more, semi-indirect still more, and direct produces the greatest loss.

TABLE 66.—LOSS IN VISUAL EFFICIENCY DURING READING UNDER DIFFERENT TYPES OF ILLUMINATION

Type of illumination	Percentage lost after	
	2 hr.	3 hr.
Daylight	5	6
Indirect	10	9
Semi-indirect	34	72
Direct	37	81

The effect of the number of lighting units in the field of vision has also been investigated by Ferree and Rand.[47] The more fixtures there are in the field of vision, the more apt the eyes are to wander from the work in hand. The percentage loss in visual efficiency after 3 hr. reading, found by Ferree and Rand for semi-indirect and direct lighting, with varying numbers of lighting units in the field of vision, is shown in Table 67. It will be observed that, as the number of fixtures in the visual field increases, the percentage loss in visual efficiency increases. As would be expected, the loss from semi-indirect lighting is not so great as that from direct. Clearly, then, the intensity of illumination is not the sole criterion of effective illumination; the character of the illumination is important too.

Even when the intensity of artificial light is equal to that of daylight illumination, it is inferior. The reason is that ordinary artificial light differs from daylight in uniformity and in color.[48] The importance of uniformity has already been discussed, and that of color may

TABLE 67.—LOSS IN VISUAL EFFICIENCY DURING READING WITH VARIOUS NUMBERS OF LIGHTING FIXTURES IN THE FIELD OF VISION

Number of fixtures	Type of lighting	
	Semi-indirect, loss, per cent	Direct, loss, per cent
0	30	40
2	40	47
4	50	67
6	78	84

be illustrated by a study made by Pierce and Weinland.[49] These investigators set up an experimental room, the walls of which were painted a flat white that could be illuminated by different colored lights, all of the same intensity. Subjects worked at a repetitive manual task in this experimental room under different colored illuminations. The results, shown in Table 68, indicate that none of the colors tested is as effective as white light. The finding that yellow is the most effective of the colors has been corroborated by other studies.[50] When the uniformity and color of artificial light approximate that of sunlight, then equal intensities of the two will be equally effective.

TABLE 68.—PRODUCTION IN RELATION TO COLOR OF ILLUMINATION

Color of Illumination	Relative Production
White	100
Yellow	93
Green	92
Blue	78
Red	76
Orange amber	76
Yellow amber	54

Ventilation.—It is a common belief that the bad effects resulting from poor ventilation are due to the reduced oxygen content of the air and to the excessive amounts of carbon dioxide present in it. This notion was completely disproved many years ago by Paul.[51] Paul's subjects sat in an airtight chamber breathing the same air over and over again, and after about 5 hr. reported the usual symptoms of discomfort. When the symptoms were at their height one subject stuck his head into a separate chamber where he breathed fresh air, but his body remained in the "stale" air. If the effects of bad ventilation were dependent upon the amount of oxygen and carbon dioxide in the air being inspired, the subject should have reported that his feelings of discomfort disappeared after the change. His discomfort, however, was not diminished. Paul did a control experiment wherein the subject's body was in the outside air with his head in the experimental chamber, thus forcing him to breathe the "stale" air. In this case the subject reported no symptoms of discomfort. Paul's findings received adequate corroboration in later studies made by the New York State Commission on Ventilation.[52] Clearly, then, feelings of distress resulting from poor ventilation in the ordinary working situation cannot be attributed to the lack of oxygen and the accumulation of carbon dioxide in the air resulting from the respiration of its occupants.

The unimportance of the oxygen and carbon dioxide content of the air also is indicated by the fact that in most poorly ventilated schools and factories the oxygen content of the air seldom falls below 19 per cent, and the carbon dioxide content seldom rises above 0.3 per cent, whereas, in order to produce adverse effects the oxygen content must be reduced below 14 per cent and the carbon dioxide content increased to 0.4 per cent.[53]

From further studies it has become increasingly clear that the function of ventilation is to aid in the heat regulation of the body. If a person is kept in an airtight chamber, breathing the same air over and over, the feelings of discomfort can be eliminated by turning on an electric fan. The increased speed of movement of the air increases its cooling power.[54] No individual can continue to work if the heat produced by the activity of his body is not dissipated. During physical activity the body produces considerable heat, and the indication is that even during "mental" activity some heat is produced over the amount given off during the resting state. The principal physiological system by means of which heat is reduced and comfort maintained is the evaporating mechanism of the skin, which produces cooling effects through perspiration. The rapidity of this evaporation is a function of the cooling power of the air, which, in turn, is dependent upon the temperature of the air, the amount of water vapor it contains (humidity), and its rate of movement. High temperature reduces the radiation and convection of heat from the body, high humidity reduces the rate of evaporation, and stagnant air impairs both convection and evaporation. By reducing either temperature or humidity or by increasing the movement or circulation of the air, ventilating conditions can be improved.

In the working situation, neither high nor low temperatures are comfortable. Bedford obtained workers' reports of comfort for various temperatures in a number of different factories.[55] The percentages of people reporting the temperature as comfortable for various degrees of warmth and cold are given in Table 69. Apparently the optimal temperature for comfort is about 62 to 63 deg. It is important to note that even at this optimal temperature all people do not feel comfortable. Similarly, as humidity rises feelings of comfort decrease. However, the three variables—temperature, humidity, and velocity of air movement—cannot be considered separately. With a constant temperature, varying the humidity will change feelings of comfort, and with both temperature and humidity constant, feelings of comfort will vary with the speed of movement of the air.[56]

TABLE 69.—PERCENTAGES OF PEOPLE REPORTING VARIOUS TEMPERATURES AS COMFORTABLE

Temperature, Deg. F.	People Reporting Comfort, Per Cent
54–55	28
56–57	46
58–59	58
60–61	77
62–63	84
64–65	78
66–67	69
68–69	60
70–71	45
72–75	45

A typical example of the increase in output resulting from improvement of ventilation under difficult conditions is reported by Wyatt, Fraser, and Stock.[57] These investigators studied weaving mills in which temperature and humidity were necessarily high, owing to the fact that steam had to be shot into the working rooms to maintain high humidity in order to prevent thread breakage. These atmospheric conditions never reached the minimum standard of comfort as judged by the workers. The problem of discomfort was solved by introducing fans. When the fans were in operation, output increased and breakage decreased, the improvement being greatest on those days when the temperature and humidity were unusually high. In addition the reports of the workers indicated that bodily comfort was increased.

Noise.—In considering the problem of noise it is not sufficient to study noise as a distracter, but rather the cumulative effects of prolonged exposure to noise should be examined. As will be seen, under certain conditions noise does disturb the individual, and unless he compensates for it by means of increased effort, production will suffer. The evidence indicates, however, that if the individual remains in the noisy situation he soon adapts to it. The latter fact is usually taken to mean that continued exposure to noise does not have any adverse effect upon the individual. This proposition, however, must be given a more detailed examination.

The mere presence of noise does not necessarily distract the worker. In a study of typists turning out form letters, Kornhauser found that 3.2 per cent more lines were written under quiet conditions, but 1.7 per cent more errors were made, as compared with production under noisy conditions.[58] In addition, for the quiet situation 23 per cent more letters had to be discarded because of faulty work. The typists reported that they felt they worked no harder in the noisy than in the quiet situation. Weston and Adams found that, in a noisy weaving mill, fitting workers with ear defenders only increased output 1 per cent.[59] Although the ear defenders did not completely eliminate the noise, they reduced it to a considerable extent. These findings do not mean that noise never affects production, but rather that the effect is probably less than is generally supposed, and that it occurs only under certain circumstances.

In an early study, Morgan presented subjects with a task wherein they were to respond to a series of stimuli by striking keys.[60] Output during noisy conditions, rather than being reduced, was actually somewhat increased. Effort, as measured by the extent of pressure exerted upon the keys, was greater during the noisy conditions than during the quiet ones. By means of a Douglas bag, Laird compared the energy consumption of typists working under quiet and noisy conditions.[61] Under the latter conditions 39 per cent more energy was consumed than under the former. Freeman has reported that under continued noisy conditions the increased effort and energy consumption, which occurs at the beginning of exposure to noise, gradually decreases and finally approaches the level characteristic of quiet conditions.[62]

Pollock and Bartlett found that noise fails to show much distracting effect with tasks that are readily automatized.[63] This is particularly true with simple motor tasks. Similarly, with tasks that are both highly interesting and complicated, noise does not appear to disturb output. On the other hand, with tasks that do not demand complete attention, noise does appear to be distracting. The noise appears to be especially disturbing when the individual comes to a difficult point in the performance of the task. Pollock and Bartlett's results agree with those of Vernon and Warner, who report that the more the work involves mental activity the greater is the disturbance from noise.[64] The latter investigators report that the amount of subjective disturbance due to noise decreases from the beginning to the end of the day, and from day to day. As might be expected from these findings, interrupted noises are more disturbing than continuous noises.[65]

Pollock and Bartlett also found that output is apt to suffer during the early stages of the performance of new tasks under conditions of noise, but that it improves during later stages.[66] It is during these early periods that the individual describes the noise as distracting and unpleasant. During the later stages of performance, as output improves, the subjective discomfort diminishes or completely passes away, and the individual appears to accept the noise, considering it as a kind of natural background to the task. Cassel and Dallenbach also found evidence that when noise is accepted as a background it has no distracting effects.[67]

The evidence presented above indicates that noise does not necessarily act as a distracter. As a matter of fact, cessation of noise may distract.[68] Interrupted noises are more apt to distract than continuous noises. When noise does produce a disturbance, a drop in output will occur unless the worker puts forth increased effort. With continued exposure to noise, the worker adapts, so that both output and effort return to normal. This adaptation is manifest from the beginning to the end of the day, and from day to day. With complex mental work, noise is more apt to have disturbing effects than with simpler manual work. When the work is either completely automatic or commands the complete concentration and interest of the individual, noise is less apt to be disturbing than when the work is semi-automatic.

The discussion so far has been confined to the types of noises that prove distracting and the conditions under which they distract. In addition it would seem fruitful to explore the relationships between personality traits and susceptibility to distraction from noise. However, there is very little adequate information available on the subject. Culpin and Smith studied the relative frequency of symptoms of nervous temperament among workers who were distracted by noise and others who were not distracted.[69] Seventy-six per cent more workers who reported that they were distracted by noise displayed these symptoms, as compared to workers who were not distracted by the noise.

The problem of the cumulative effects of noise should be regarded from two points of view, that of organic effects and that of psychological effects. It seems to have been clearly demonstrated that prolonged exposure to noise does produce permanent deterioration in the hearing apparatus of the inner ear. Boilermaker's disease is a common example. As a further instance, airplane pilots were found to have a loss in sensitivity to high tones as indicated by audiometer tests.[70] The loss was sometimes apparent at quite an early point in the pilot's flying experience, in some instances appearing after the first few hundred hours in the air. In the beginning the defect was temporary, but after a time it became permanent.

The other type of permanent effect, *i.e.*, the psychological, might be expected to manifest itself in terms of various personality disorders. It is commonly believed that such disorders do occur among workers who have been employed for a considerable time in such noisy industries as stamping and weaving mills. However, the evidence here is primarily based on casual observation, and therefore no definite conclusions can be drawn at the present time.

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CHAPTER XI

EFFECTIVE METHODS OF WORK AND DESIGN OF EQUIPMENT

The preceding chapter was concerned with the effects of various conditions of work upon productivity, and it was pointed out that under certain working conditions there was more output than under other conditions. It is apparent that effectiveness of work will also be a function of the method of work when more than one method can be employed. Thus a nail is driven home with greater dispatch if the hammer is held at the foot of the handle rather than at the head, since holding the hammer at the foot permits a more powerful blow. Similarly a long-handled hammer will be more effective in driving spikes than one with a short handle. It is therefore necessary that we examine the techniques for studying methods of work and consider some of the findings of past investigations.

The discussion will be concerned principally with work of a manual nature, such as is found in factory operations, and most of the examples will be drawn from jobs of this kind. In part this is due to the industrial setting in which most of the problems in work methods arose. In many other kinds of jobs, such as clerical jobs, manual activities also are very important, and therefore means for systematic study of work methods and the results of studies of manual activities will be of significance in areas outside factory operations.

TIME-AND-MOTION ECONOMY

The early job analyses of Taylor and Gilbreth were primarily designed to reveal how the movements of the body could be improved so as to bring about an increased productiveness in work.[1] Thus time-and-motion analyses became the basis for studies of time-and-motion economy. In order to develop better methods of work for a given job, a motion-cycle chart is developed as a result of a time-and-motion study. The chart is then analyzed, unnecessary movements are noted and eliminated, and new movements or new combinations of old effective movements are suggested.

The Method of Time-and-motion Economy.—It is beyond the scope of the present discussion to consider in any great detail the technique of time-and-motion economy. The size of the numerous texts in the field testifies to its extent and manifold mechanics. We shall here consider the method in its barest outline, since we are only interested in its contribution to the problem of achieving the most effective motions.

As an example of the manner in which the economy is applied, we shall consider a hypothetical case of a simple nut-and-bolt assembly. In Table 70 are given fictitious data for the movements and times of movements for two workers. Although worker B takes less time to complete a cycle of work, it is apparent from an examination of the movements of the two workers that A is in some respects superior to B. A takes only 1.3 sec. to pick up the two parts and bring them to the working position for assembly, whereas worker B requires 1.6 seconds. The difference lies in the fact that A makes simultaneous movements, while the movements of B are consecutive. On the other hand, B is more effective than A in making the assembly, requiring only 2.2 sec. as compared with 3.2 sec. for A. Here it would appear to be quicker to turn the nut onto the bolt than to turn the bolt into the nut. Thus,

TABLE 70.—HYPOTHETICAL EXAMPLE OF THE APPLICATION OF TIME-AND-MOTION ECONOMY TO A SIMPLE NUT-AND-BOLT ASSEMBLY TASK

Worker A			Worker B			Best method		
Left hand	Time, sec.	Right hand	Left hand	Time, sec.	Right hand	Left hand	Time, sec.	Right hand
Reach for and select nut	1.1	Reach for and select bolt	Reach for and select bolt	0.7	Rest	Reach for and select bolt	1.1	Reach for and select nut
Carry nut to working area	0.2	Carry bolt to working area	Carry bolt to working area	0.7	Reach for and select nut	Carry bolt to working area	0.2	Carry nut to working area
Hold nut	3.2	Screw bolt into nut	Hold bolt	0.2	Carry nut to working area	Hold bolt	2.2	Screw nut onto bolt
Rest	0.5	Carry assembly to dump pile	Hold bolt	2.2	Screw nut onto bolt	Drop assembly to box under hands	0.1	Rest
Repeat cycle	. . .	. . . .	Carry assembly to dump pile	0.6	Rest	Repeat cycle	. . .	. . . .
			Repeat cycle	. . .	. . . .			
Total time	5.0	. . . .	Total time	4.4	. . . .	Total time	3.6	. . . .

for a best method of work, A's procedure for picking up the parts is more effective than B's, and, for assembling, B's method is more effective than A's. Finally, both workers place their completed assemblies away from the central working position. This is unnecessary, and in a best method of work the assemblies simply would be dropped into a box underneath the hands.

Putting together the superior movements of A and of B and eliminating the unnecessary movement just noted yield a best method of making the assembly, which requires much less time than the method of either worker requires. Under the new method of work, production would be 22 per cent greater than that achieved by B's method and 39 per cent greater than that achieved by A's. On the average the new method of work would increase production by 30 per cent.

The Use of Time-and-motion Economy.—From this illustration it can be seen that time-and-motion economy involves the retention of those movements or combinations of movements in an old method of work that are found to be quickest and the elimination of extraneous movements and periods of inactivity. With the resultant new method of work it is believed by exponents of the method that not only can greater levels of productivity be expected, but also the exact time needed to complete a unit of work is known. Thus production plans, rates of pay, and the like can be readjusted on the basis of the new schedule. Essentially, therefore, time-and-motion economy results in a hypothetical description of behavior that is used as a basis for prediction in further planning.

The psychologist's quarrel with time-and-motion economy is in terms of the basic postulates on which it rests. It follows that, if the basic postulates are false, then the method cannot be expected to give an exact prediction of human behavior. It was noted in the chapter dealing with criteria of job proficiency that in time study certain allowances ordinarily are added to predicted times for completion of a unit of work, allowances made for personal time, delays, etc. These allowances are made chiefly on an arbitrary basis. This fact in and of itself is sufficient to demonstrate that the method is not exact. In the following section, however, we shall examine in greater detail the psychologist's criticisms of time-and-motion economy in order to have a more complete understanding of the problem.

CRITICISMS OF TIME-AND-MOTION ECONOMY

Time-and-motion economy originally grew out of attempts to increase output and primarily has been in the hands of the industrial engineer. It is not surprising therefore that the industrial psychologist, whose field of study is human behavior and who seeks to evaluate solutions to industrial problems in terms of their wider human implications, should find much to criticize in time-and-motion economy.[2] There is, of course, much about time-and-motion economy with which the psychologist is in accord. But these areas of agreement are principally concerned with administrative means for improving production, such as relieving skilled workers of those simple activities that can be performed just as well by unskilled persons, or eliminating unnecessary idle time. These aspects of time-and-motion economy are problems of production management rather than of psychology.

The psychologist's concern is with time-and-motion economy as a technique for improving the effectiveness of work by revising the movements made by the worker in carrying out his job. From the point of view of the industrial psychologist, time-and-motion economy is open to criticism on four counts as follows: it is based upon an unsound atomistic conception of human behavior, it assumes a high degree of constancy of performance, it fails to take into account individual differences, and it uses far too narrow a criterion in gauging the effectiveness of work.

Atomistic Conception of Human Behavior.—Time-and-motion economy assumes that each individual movement of a total complex task can be considered as a separate and independent unit. If one movement is eliminated, then the total time to complete the task is reduced in proportion to that which was required in the execution of that movement as part of the complete sequence. This atomistic notion of human behavior is open to serious criticism.[3] The individual working at a task, however simple, knits all the part activities into a whole; therefore the changing of any part activity may be expected to change the pattern of the larger task. Time-and-motion analysts have fallen into the fallacy of thinking of human behavior as being capable of analysis into distinct units like blocks, which are summative in nature and which may be piled up now into one pattern and now into another, without affecting the character of any single element.

The inadequacy of this atomistic conception of movements may be demonstrated very simply from the results of an experiment. Subjects were presented with six keys arranged in the following fashion:

A D F
B C E

and were instructed to tap them in a certain sequence, the time needed to make the movement between each pair of keys being recorded. Some of the movements were eliminated in a second sequence, and times of movements again recorded. Each set of records, of course, was taken after the subjects had mastered the task and had reached their maximum speed of movement. Two examples of the results found with the key-tapping task are given in Table 71. In the first example the original sequence required 2.42 sec. The elimination of two movements that required 0.71 sec. was expected to reduce the total time to 1.71 sec. (2.42 − 0.71 = 1.71). The actual time required to perform the second sequence was 1.81 sec. All but one of the movements retained in the second sequence required more time than they had required in the original sequence. Elimination of movements therefore not only did not reduce the time as much as was expected but actually increased the times taken to perform most of the remaining individual movements. In the second example, opposite results were obtained. The elimination of some of the movements reduced

TABLE 71.—THE EFFECTS OF THE ELIMINATION OF MOVEMENTS ON SPEED OF ACTIVITY IN SUCCESSIVE TAPPING OF KEYS

Movement	Average time, sec.		
	First sequence	Second sequence	Ratio of second to first
Example I			
AB	0.40	0.44	110
BC	0.28	0.30	107
CD	0.39	eliminated	
DC	0.32	eliminated	
CE	0.30	0.29	97
EF	0.39	0.41	105
FA	0.34	0.37	109
Total time	2.42	1.81	
Expected total time	....	1.71	
Example II			
BC	0.23	0.21	91
CD	0.30	eliminated	
DC	0.29	eliminated	
CE	0.17	0.11	65
EA	0.31	0.30	97
Total time	1.30	0.62	
Expected total time	....	0.71	

the time much more than was expected. The time required to perform one of the remaining movements in the new sequence was very significantly reduced.

Barnes and Mundel have reported an experiment that bears on this point.[4] These investigators had subjects pick up pins and insert them one at a time into a hole, separate times being noted for the various parts of the operation. In all tests the hole was ¼ in. in diameter, but the aperture in four of the five experimental conditions varied in size and was funnel-shaped. The results, given in Table 72, indicate that the times required for the various parts of the task vary with the size of the aperture. This is to be expected for the time needed to position the pin for insertion as well as for the time required to insert it, but it is not apparent why the time required simply to carry the pin from the point of supply to the hole should also vary with the size of the aperture. In any planning based upon time-and-motion economy, this movement would be considered to be constant, regardless of the tasks that precede or follow it.

It is clear therefore that the time required for executing one part movement in a total sequence will vary with characteristics in the working situation and with other part movements that may be only indirectly connected with it. It must be concluded that any task involving a series of movements will be integrated into a whole by the worker and that each component movement may interact upon and affect every other movement. The extent of this interaction may be great or small, but it will exist to some degree and cannot be assumed to be absent. Any task therefore must be thought of as an integrated whole whose characteristics are changed by the change of any of its parts.

TABLE 72.—TIMES INVOLVED IN PERFORMING VARIOUS PARTS OF THE SIMPLE TASK OF INSERTING A PIN INTO A HOLE, IN RELATION TO THE SIZE OF THE APERTURE OF THE HOLE

Size of aperture, in.	Time to carry pin from supply to hole, sec.	Time to position pin for insertion, sec.	Time to insert and remove pin, sec.
1	0.311	0.281	0.190
¾	0.304	0.327	0.184
½	0.347	0.290	0.179
⅜	0.369	0.295	0.176
¼	0.384	0.485	0.133

Assumption of a High Degree of Consistency of Performance.—The reader of discourses on time-and-motion economy frequently misses the assumption, implicit in the method, that human performance in any given activity displays a high degree of consistency. In an earlier chapter on criteria of job proficiency it was pointed out, in the discussion of reliability, that the consistency of human performance varies markedly from one task to another. Behavior is seldom perfectly constant; even very simple activities are variable.

In a time-and-motion economy study usually only a few cycles of the task are recorded, and the times for the different parts of the task under consideration are based upon averages obtained from these few cycles. The simple average is a statistic describing a set of data, and as a description it may or may not possess acceptable reliability. If the data are highly consistent, then their average will be a reliable description. On the other hand, if the values from which the average is computed vary markedly, then the average will be an unreliable statistic. This is a point that is generally ignored in time-and-motion economy, since it is merely assumed in the method that the performances being studied are highly consistent and that therefore the averages are statistically reliable.

In Table 73 are given the results of a time-and-motion study made of two workers engaged in forming links out of pieces of wire.[5] Times were taken for each worker during 11 cycles of work. Of particular pertinence here is the degree of variability in specific performances. In terms of total time required to complete a cycle of work, the range for worker A was 23 per cent of her average time and for worker B, 51 per cent. For the different part activities the amount of variation in performance will be seen to be exceedingly high in some cases. For most of these part activities an average figure, such as a mean, will not be sufficiently representative to be considered an accurate description of the activity. It should be apparent that some performances are so variable that an exact prediction of them is impossible. Even when the averages for part activities are based on many cycles, there still will be many of these activities so variable that the average will not serve as an efficient descriptive statistic.

Failure to Take Individual Differences into Account.—The avowed purpose of time-and-motion economy is to discover the best method of work. The assumption is made that there is one sequence of movements that will be best for all workers. This notion completely denies the fact that individuals differ. Two workers may be equally effective in the performance of a task but nevertheless employ widely

TABLE 73.—TIMES REQUIRED BY TWO WORKERS TO FORM A LINK OUT OF A PIECE OF WIRE, THE PROCESS BEING REPEATED ELEVEN TIMES

Part activity	Worker A				Worker B			
	Average time		Range of times		Average time		Range of times	
	Min.	Per cent	Min.	Per cent	Min.	Per cent	Min.	Per cent
Reaches for piece of wire.......	0.005	8	0.004–0.005	20	0.007	8	0.006–0.008	26
Selects and grasps piece of wire..........	0.004	7	0.002–0.009	175	0.005	6	0.002–0.009	140
Carries wire to bending apparatus.......	0.006	10	0.005–0.007	33	0.008	10	0.006–0.012	75
Inserts wire in apparatus....	0.007	11	0.005–0.009	57	0.013	16	0.005–0.017	92
Forms link with apparatus....	0.008	13	0.007–0.009	23	0.010	12	0.009–0.010	10
Operates apparatus lever..	0.003	5	0.000	0	0.006	7	0.005–0.007	33
Takes out wire and inserts other end in apparatus....	0.018	30	0.015–0.027	72	0.019	22	0.017–0.022	26
Forms link on other end of wire..........	0.007	11	0.000	0	0.010	12	0.009–0.010	10
Operates apparatus lever..	0.003	5	0.000	0	0.006	7	0.005–0.006	17
Total.........	0.061	100	0.055–0.069	23	0.080	100	0.071–0.114	51

different movements to accomplish the task. There is no reason to suppose, as Farmer has pointed out, that a standard set of movements will be the best for all workers.[6] This is not to deny that optimal methods of work can be found, but it is one thing to think of a particular method of work as being best for *all* persons, and quite a different thing to think of this method as being more effective than another for *most* persons. As Jenkins has suggested, the worker should not be adapted to the method of work, but rather the method of work should be adapted to the worker.[7] Farmer has found that the study of the individual worker, with the aim of finding the best set of movements for him, is highly effective.[8]

Narrowness of Criterion in Gauging Effectiveness of Work.— Time-and-motion economy invariably evaluates the effectiveness of industrial work in terms of speed of production. When a number of movements are being compared, that movement which requires the least time is always considered to be the best. However, as Farmer has pointed out, the quickest movement is not necessarily the best in all respects.[9] Although rapid movements result in higher levels of production, they may also increase feelings of tiredness to such an extent that after a time the worker may be unable to continue on the job and may even rebel. Farmer obtained the cooperation of an excellent worker who was already highly motivated, so that she volunteered to work as fast as she possibly could for a trial period. Compared to her normal rate of work, her output during this trial period of a few hours was doubled, but at the end of this period she was so exhausted that she could no longer continue working.

The criteria of worker effectiveness discussed in a previous chapter can find appropriate application in studies on the evaluation of methods of work. In addition to these criteria there are subjective factors affecting the worker, which must also be included in the evaluation. Feelings of boredom and monotony, to be discussed in a later chapter, are real and significant conditioners of worker effectiveness. They result when there is lack of harmony between the worker's mental and emotional reactions and the demands of the job, and they may be directly affected by particular methods of work. The point to be made here is that amount produced alone is not sufficient as a criterion to evaluate a method of work, and that it should be supplemented by other available measures of the worker's reactions.

It will be well to heed Farmer's warning that as long as the investigation of better methods of work is left completely in the hands of those whose primary purpose is to increase production, the worker, justifiably or not, will tend to feel that he is being exploited. On the other hand, Farmer has demonstrated that when the worker realizes that the purpose of a time-and-motion study is the reduction of all aspects of fatigue, he will regard the matter in an entirely different light.

TIME-AND-MOTION ECONOMY VERSUS TIME-AND-MOTION STUDY

In view of the above-mentioned criticisms it is doubtful that time-and-motion economy can be justified as an exact method. If it is based upon tenuous assumptions, then any predictions of human behavior made on the basis of it necessarily will be in error. In the foregoing examples it was shown that such predictions are inaccurate. Not only are the means inadequate, but the ends also cannot be considered wholly justified. This is not to imply, however, that methods of work cannot be improved through systematic investigation. Such investigation, as we shall see, does yield important results. A differentiation must be made, however, between time-and-motion economy and time-and-motion study.

Difference in Aims.—Time-and-motion study is simply a systematic procedure for providing a description of the motions involved in performing a particular task. Its purpose is solely to provide a picture of the manner in which a job is being performed. Time-and-motion economy uses the results obtained from time-and-motion study as a point of departure. The former begins where the latter leaves off. Time-and-motion economy also uses the results of time-and-motion study as a basis for drawing conclusions concerning ways in which the speed of work can be increased. The analysis of motions therefore provides the factual description of the workers' responses, which is then used as a basis for conclusions concerning hypothetical economy procedures.

Time-and-motion economy, however, ordinarily employs other means than improved methods of work for increasing production. Farmer has pointed out that a careful examination of discussions of time-and-motion economy and illustrative applications of it will reveal that not infrequently changes other than those made in the methods of work are introduced.[10] Thus, on the basis of an analysis of the movements involved in a job, a new sequence of movements will be set up, and, it is important to note, new rates of pay are likely to be instituted and perhaps a change in duties required of the worker. Any increases in productivity cannot then be ascribed simply to the new methods of work, since other conditions also have been changed. Increases in production resulting from the application of time-and-motion economy therefore cannot be used to justify the new methods of work. If increases in production do occur, justification for the entire procedure used is obtained, but not justification for any one aspect of it.

Time-and-motion Study as a Basis for Increasing Effectiveness of Work.—Recognizing the fact that time-and-motion study is simply the systematic description of the movements required by a job and, in and of itself, tells nothing of the ways in which a job can be improved, places the whole problem on a sounder foundation. Time-and-motion analysis therefore does not need justification on the basis of how much it improves methods of work but rather stands independently on its own right as a descriptive method for investigating human work.

In some instances time-and-motion study may directly reveal ways in which work can be improved. The illustration given in Table 70 of a simple nut-and-bolt assembly is a case in point. Here the analysis showed that the workers were making a large movement in carrying the completed assembly to the outer boarders of the working area, when they could have dropped the assembly into a container under the hands just as easily. The difficulty in drawing a conclusion such as this from a study of the pattern of movements lies in the fact that there might be elements in the picture that are overlooked. Indeed we are here approximating the method of time-and-motion economy. Therefore changes in methods of work arrived at from simple inspection of the motion-cycle chart must be made with caution and should not be accepted as final until their effectiveness has been demonstrated empirically.

For the most part, insofar as improvement of methods of work is concerned, time-and-motion study will be most valuable as a means of indicating specific research projects that should be conducted in studying the effectiveness of types of movements or methods of work. This can be illustrated by means of the results of a time-and-motion study made of the operations of a clerk in posting entries on a ledger sheet by means of a bookkeeping machine. The motion-cycle chart constructed from motion pictures taken of a number of cycles of work indicated that the left hand was idle for a period amounting to some 20 per cent of the total time. During this period the right hand was engaged in inserting numbers into the keyboard, and there was nothing by way of handling papers or other acts that the left hand could be doing. It was suggested that some time might be saved by simultaneously inserting numbers into the keyboard with both hands. Since there was no experience with the speed and accuracy of bimanual insertion of numbers, a study of the feasibility and effectiveness of this type of operation was indicated. In this case the motion analysis directed the thinking of the investigators toward a specific research project related to a particular method of work.

Time-and-motion study therefore is likely to raise more problems than it solves. It will be the means for focusing attention on areas that need exploration. In this sense it makes a very significant contribution, since the problems with respect to improving methods of work are usually stated in general terms, such as increasing production or reducing work decrement, rather than in specific terms of particular problems amenable to immediate study.

PROBLEMS IN THE ANALYSIS AND EVALUATION OF MOVEMENTS

Before effective methods of work are discussed it will be well to consider some factors that may affect the results of motion analyses and investigations aimed at the evaluation of different types of motions. It is necessary to know about certain circumstances that may limit or reduce the accuracy of such studies and thereby severely limit the conclusions that may be drawn from them.

Conditions under Which Movements Are Studied.—It is apparent that an investigation of movements made under one set of conditions may give results at variance with those obtained under another set of conditions. Thus Gilbreth noted that bricklayers used different movements when laying bricks quickly than when laying them slowly, and used still a different set of movements when they were demonstrating how to lay bricks.[11] Similarly it may well be expected that the set of movements used in a particular task will be different under conditions of inadequate illumination than under superior conditions of illumination. An investigation of motions therefore should be conducted under exactly the same conditions as those which may be expected to occur on the actual job.

Perhaps the most variable conditions will be found in connection with the factor of motivation. The performance of a worker who is being used as a subject in a time-and-motion study will be a direct function of how he reacts to the situation. If he fears that the results will be used as a basis for setting up high rate requirements, he will work at a slower rate than he might under other circumstances. In a plant where a low level of morale is prevalent significant error in the results of the motion study will inevitably occur. But even if the worker is certain that the results of the study will not be detrimental to his interests, there still may be certain untoward effects. The mere fact that he is being observed or photographed may influence his performance. For most workers, some time for adaptation to the newness of the experimental situation will be required, and it will be difficult to say whether the period of adaptation is to be measured in terms of hours or of weeks, because of the number and complexity of the factors conditioning this adaptation. Certainly the time will not be a matter of minutes, and ordinarily in a motion analysis little account is taken of the actual time needed for the worker to adapt to a situation where his performance is being observed and recorded.

Individuals Used in Motion-study Investigations.—As was pointed out in an earlier chapter, the workers used in a time-and-motion study are likely not to be representative of the total group of workers. In many cases a foreman or a superior worker is used as the subject in making the analysis. Persons such as these may differ from the general run of workers not only in terms of their speed of work but also in terms of the number and kinds of movements that they utilize.[12] If a scientific solution is sought, it is necessary to make sure that the motion analysis is made for workers who are truly representative of all levels of proficiency. Unless this is done the resulting analysis may be without value.

A similar problem exists in connection with laboratory studies of the effectiveness of different types of movements. In certain instances college students, or the investigators themselves, may serve as subjects. Such individuals will differ from employed workers not only with respect to motivation but also with respect to their pattern of abilities and previous work experiences. Differences such as these may well invalidate findings with respect to the effectiveness of different types of movements, especially when these findings are generalized to the actual industrial situation.

Laboratory Investigations.—As we have seen, time-and-motion study is likely to suggest specific research projects on particular methods of work. This fact, together with a growing inclination to substitute the findings of experimental investigation for the intuitive conclusions developed by time-and-motion economy, has led to increasing numbers of laboratory investigations concerned with the effectiveness of different types of movements. These laboratory investigations received an impetus during the past war, which produced a variety of problems with respect to new types of equipment and new types of jobs.

Certain of the laboratory investigations, however, have not escaped the error characteristic of time-and-motion economy. For example, some investigators accepted the dictum that a movement performed in isolation retains the same characteristics as when it is performed as one part of a total sequence of acts. Thus in the laboratory experiment a comparison of the effectiveness of curved movements of the arm with movements along a straight line might be effected simply by having the subjects move their arms in the specified directions and at supposed maximum speeds of movement. If the speed of the curved movement is found to be higher than that for movement along a straight line, the former would be considered to be effective under all circumstances, whether the movement was involved in picking up items for an assembly operation, in replacing tools on a bench, or moving controls in operating a machine. It is apparent from the criticisms of time-and-motion economy already discussed that such an interpretation cannot be considered scientifically justified.

The fact that the evaluation of a movement when performed in isolation might be different from an evaluation of the movement when executed as part of a total act can be illustrated by a simple study. In this instance a comparison was made between the effectiveness of simultaneous movements of both arms in opposite and symmetrical directions and simultaneous movements of the arms in the same direction. The subject was seated at a workbench. For symmetrical movements one box was arranged 1½ ft. to the right of the center of the body and another box the same distance to the left; when asymmetrical movements were to be made, both boxes were arranged on the right. In one part of the experiment the subject simply moved his hands from the middle of the workbench to the boxes and back again. In another part he reached to the boxes, selected a nut from one and a bolt from the other, carried them back to the center of the workbench, assembled them, and dropped the completed assembly to the workbench. Thus in the first part of the experiment the simple movement of the hands in symmetrical and asymmetrical directions was studied, and in the other this movement was included as part of a sequence of acts.

It was found that when dealing with the simple movement of the arms the asymmetrical movements were made at the rate of 60.3 per minute and the symmetrical at 74.4 per minute. From these results it would be concluded that symmetrical movements are more effective than asymmetrical. In the second part of the experiment, however, it was found that the number of assemblies made per minute when asymmetrical movements were employed was 6.6 per minute, and for symmetrical movements, 6.3. In this case the difference in symmetry of movements did not appear to produce significant differences in effectiveness.

It is apparent from the foregoing discussion that movements cannot be studied in isolation in any laboratory investigation. Rather they must be included as part of an entire task in order that a correct evaluation can be made. In the foregoing problem on the relative effectiveness of symmetrical and asymmetrical movements it would be necessary to compare the two types of responses when the arms are engaged in picking up and depositing different types of objects in executing a wide variety of different tasks, before a statement would be justified as to the general effectiveness of the two kinds of movement.

TYPES OF MOVEMENTS

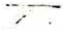
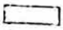
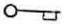
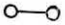
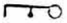
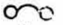
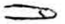
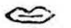
Before considering the experimental findings with regard to the effectiveness of different methods of work, it will be well to have a clear understanding of the different types of movements. The various movements that a worker makes can be classified in a variety of different ways. We shall here consider three different bases according to which movements have been classified, viz., their purpose, their skill requirements, and their physiological nature.

Purpose of the Movements.—Time-and-motion study employs a classification of movements into types called "therbligs." Each therblig constitutes a basic element of movement and may refer to a number of different responses, all of which have the same purpose. Thus, whether the worker is carrying in his hand a tool, a bolt, or a fixture of some sort, the purpose of the movement is the same, to convey an object from one place to another. All such movements are grouped together in the category of "transport loaded" and are given the same therblig notation. The use of therbligs as in time-and-motion study gives a description of the purpose for which the movement is made. In and of itself the therblig classification does not describe the nature of the movement, such as whether it is fast or slow or easy or difficult to perform. This therblig type of classification of movements is important principally in such problems as changing the sequence of movements and in the elimination of unnecessary movements.

Skill Requirements of the Movements.—For many jobs the major problem is to simplify the tasks in terms of worker requirements. Job simplification has generally taken the form of reducing the number or variety of movements a worker utilizes in the execution of the job. The assumption is that by this means the worker will require less training and may possess a lower degree of skill. It does not necessarily follow, however, that the reduction of the number and variety of motions will invariably make the task simpler for the worker. Indeed in some cases it might have just the opposite effect. It has been found that the more skillful workers generally employ fewer movements than the less skillful, and this suggests that, in terms of skill requirements for a given task, reduction in the number of movements might actually make greater demands upon the worker.

A more fruitful approach to the problem of job simplification appears to be the classification of movements into types according to the nature of their skill requirements. Fairchild attempted to do this by classifying movements in terms of basic skills involved.[13] Fairchild's basic types of skill, together with their symbolic notations, are shown in Table 74. Each of the types of skills was defined; for example, "motion saving" refers to the worker's ability to direct a movement with control and without error, and "adaptation to machine" refers to the worker's knowledge and habits that enable him to regulate the machine and operate it and use it in accordance with its capacities.

TABLE 74.—SYSTEM OF SKILL CLASSIFICATION AND NOTATION DEVISED BY FAIRCHILD

	Adaptation to machine
	Adaptation to materials
	Adaptation to tools
	Accuracy of movement
	Motion saving
	Adaptation of energy to need
	Self-confidence
	Plan
	Sensitivity of eye
	Sensitivity of ear
	Sensitivity of touch
	Sensitivity of taste
	Sensitivity of smell
	Kinesthetic sensitivity

In making the skill analysis the ordinary time-and-motion study is conducted, noting the proper skill factor in the motion-cycle chart along with each therblig to which it refers. This gives an analysis of the job not only in terms of the movements made but also in terms of the skill requirements. For any given job, dividing the number of skill factors by the number of therbligs gives a ratio that reflects the skill requirements. Ratios calculated for different workers or for different jobs permit rough comparisons in terms of skill requirements.

Fairchild's technique of skill analysis is cited here merely by way of illustration of a systematic approach. Many investigators will not agree either with her concept of skill or with her method of analysis. Certainly doubt can be cast upon the use of the skill-therblig average, which involves items that differ qualitatively and are not amenable to such arithmetic treatment. Nevertheless her method opens an attack on the problem from a different point of view, and further work along these general lines should be fruitful.

Physiological Nature of the Movements.—Two types of voluntary movements of parts of the body may be distinguished: fixed or controlled movements and ballistic movements.[14] In fixed or controlled movements, opposed or antagonistic muscles operate against each other. When the contraction of one set of muscles is stronger than that of the other, movement of the part results. The thumb-and-finger method of writing is an example of this type of movement. In ballistic movements the movement of the part is initiated by the contraction of the positive muscle group and continues owing to its momentum. The activity of the positive muscle group after the beginning of the movement, and the activity of the antagonistic muscles throughout the whole movement, are at a minimum. The ballistic movement is stopped by a contraction of the antagonistic muscles, by the dissipation of the momentum of the movement, or by the part of the body involved striking an object. Hence, in order to employ momentum effectively in the movement of parts of the body, ballistic rather than fixed or controlled movements should be used.

Hartson has given considerable attention to the problem of fixed versus ballistic movements in skilled activities and finds the following advantages for the ballistic type of movement:[15]

1. Less decrement. Since fixed movements are usually shorter than ballistic, it is ordinarily thought that there will be less work decrement. However, the reverse appears to be true, which might be expected inasmuch as ballistic movements involve less muscular activity.
2. Less deterioration in the quality of movement with continuous activity. If a series of acts employing fixed movements is continued for a long time, the movements are soon characterized by decreased accuracy. In finger writing, for example, there is a rapid deterioration in the quality of the writing.
3. More powerful. Since ballistic movements use momentum and the force of the body weight, they are more powerful than fixed movements.
4. More rapid. The greater rapidity of ballistic movements has been demonstrated in a number of activities such as tapping, typing, and packing operations.
5. Less likelihood of cramp. Forms of "occupational neuritis" such as writer's cramp, telegrapher's wrist, and pitcher's glass arm are much less likely to occur when ballistic movements are employed.
6. More accurate when speed is a consideration. With fine movements requiring considerable accuracy, fixed movements will be more accurate. On the other hand, with larger movements in which speed is important, ballistic movements are found to be more accurate.

In certain situations momentum is undesirable, since the worker must use his muscles to counteract its effects. If the momentum could be avoided, the worker would not have to expend energy to overcome its effects. The momentum of an object is equal to its weight (mass) multiplied by its velocity. Therefore, if either weight or speed of movement were minimized, the momentum would be reduced. The objects moved by the worker are materials, tools and equipment, and parts of his body. Ordinarily the weight of materials cannot be reduced, although that of tools and equipment may be. In order to reduce the weight of the parts of the body that are moved, it is sometimes suggested that finger movements be used rather than wrist movements, wrist movements rather than arm movements, and arm movements rather than shoulder movements. However, there is some evidence against this preferential hierarchy of movements.[16] In certain instances finger movements are likely to be less accurate and show more decrement than arm movements. One way of reducing the work load is to have the arms and hands move through the shortest distance possible. Hence rearrangement of the workplace, so that materials are found at points close to where they will be manipulated, will minimize the part played by momentum.

EFFECTIVENESS OF HAND AND ARM MOVEMENTS

Treatises on time-and-motion economy present a variety of principles regarding the effectiveness of various movements of the hands and arms. As has been pointed out, such principles usually are based upon experience with many different industrial tasks. The difficulty with such principles, however, is that to a large extent they are based upon studies in which more than one variable was changed in the experimental situation in which the method of work was being investigated. Under such circumstances it is difficult to ascertain the extent to which any particular change contributed to the resulting increase in production. In the following sections, therefore, consideration will be given only to evaluations of different methods of work that are based upon experimental investigation. The intent will not be to review all the many investigations on the effectiveness of movements but rather to consider certain ones that would appear to be of most importance insofar as industrial work is concerned.

One-hand Movements versus Simultaneous Bimanual Movements.—It is a basic principle of time-and-motion economy that both hands should be working at the same time. In part this is done to save operation time, but in part it is based upon the belief that simultaneous motions of both arms are more natural and easier than individual movements of either arm. As evidence of the greater effectiveness of the bimanual method of work, investigations such as the following ones by Barnes are offered.[17]

In an older method for a bolt-and-washer assembly the worker picked up a bolt with her left hand, and then with her right hand she picked up and placed on the bolt in succession a lock washer, a plain steel washer, and a rubber washer. The bins from which the worker picked up the parts and into which she dropped the completed assembly were arranged one next to the other in a straight line on the work table in front of her.

In a newer method of work the bins containing the parts were arranged in a semicircle on the table in front of the worker. To the central bin, which contained bolts, the worker reached with both hands and picked up two bolts, which she placed pointing up in two countersunk holes in the table before her. Then she reached with both hands to the bins on either side of the central bin, both of these bins containing lock washers. Selecting a lock washer with each hand, she carried one to one bolt and the other to the second and assembled them. The next two bins from the center contained the steel washers, and the outermost two bins, the rubber washers. In turn the worker took two of each kind and assembled them on the bolts. The two hands moved simultaneously, neither being idle while the other was in operation, beginning and ending their movements at the same time and in opposite and symmetrical (mirror image) movements.

That the newer method of work was more effective than the older is indicated by the fact that the average time required to make an assembly under the older method was 0.0838 min. whereas the average time for the newer method was 0.0546, a saving in time of 35 per cent. However, it is obviously difficult to state with any degree of certainty whether the saving was due to the fact that both hands were employed in productive work at the same time, or whether the new arrangement of the bins or some other change was the determining factor. Such investigations therefore cannot be considered satisfactory evidence that simultaneous bimanual movements are more effective than independent singlehanded movements.

What is needed is a task wherein exactly the same movements can be made with either the two hands simultaneously or each hand separately in time. Barnes, Mundel, and MacKenzie have provided some pertinent evidence.[18] These investigators had subjects pick up screw nuts and drop them in a receiver hole. In one part of the investigation the nuts were picked up one at a time by one hand, and in another part they were picked up two at a time with simultaneous movements of both hands. Two different types of container bins for the nuts were employed. One was a simple box-shaped bin, and the other a bin equipped with a tray that permitted the nut to be slid to the edge for greater ease in grasping. The results are given in Table 75. It is apparent from these findings that, regardless of the type of bin employed, the singlehanded operation is quicker than the bimanual operation. This investigation throws doubt on the greater effectiveness of simultaneous motions of both hands as compared with movements of one hand.

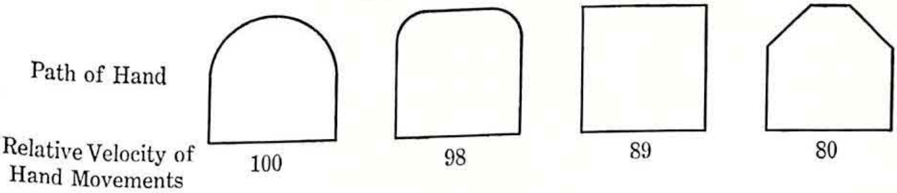
TABLE 75.—TIMES REQUIRED TO PERFORM THE SIMPLE OPERATION OF PICKING UP SCREW NUTS FROM A BIN AND DROPPING THEM INTO A HOLE WHEN DONE AS A SINGLEHANDED AND AS A BIMANUAL OPERATION

Type of operation	Box bin			Bin with tray		
	Time to grasp nut, sec.	Time to complete cycle of work, sec.		Time to grasp nut, sec.	Time to complete cycle of work, sec.	
		One nut	Two nuts		One nut	Two nuts
Singlehanded operation:						
Right hand	0.481	1.138	2.276	0.294	0.858	1.716
Left hand	0.526	1.191	2.382	0.289	0.936	1.926
Simultaneous bimanual operation:						
Right hand	0.792		2.953	0.432		2.226
Left hand	0.719			0.410		

Curved Motions.—Barnes found that in a simple act in which the individual carried an object in his hand away from the body, then stopped and changed direction and carried it back toward the body, 15 to 24 per cent of the time was consumed simply in changing direction.[19] If the movements of the hand could be arranged so that no stop was necessary, as by curved motions, this waste in time could be eliminated. Barnes has shown how the application of this principle effected a marked saving in time.[20] In folding sheets of paper in one plant the worker folded the sheet over with her left hand, and then, with a creasing tool in her right hand, she struck the fold in the middle and creased it. She moved the tool away from her body along the fold to the further edge of the paper; then reversing the direction of movement of her hand, she moved the tool back along the fold toward her body. In an improved procedure the worker folded over the sheet of paper with the left hand in the previous manner, but she struck the fold with the tool on the near edge and moved the tool away from herself in an S-shaped curve, so that at the end of a curved movement, the hand was brought back toward the body. The old method required 0.009 min. to make a fold, whereas the new method required only 0.005 min., a saving in time of 44 per cent.

Another study, demonstrating the effectiveness of curved movements over movements along straight lines involving sudden changes of direction, was made by Barnes and Mundel.[21] These investigators had subjects move their hands along various pathways having forms as indicated in Table 76. It will be observed from this table that the speed of movement is greater along those paths which permit greater curvature in movements, and that it is less along those pathways which require many abrupt changes in direction.

TABLE 76.—VELOCITY OF CONTINUOUS HAND MOVEMENTS ALONG FOUR DIFFERENT PATHS



Farmer found that curved motions were a more effective method of work in candymaking.[22] In the original method of work, candy centers were picked up from a tray, dipped into a pot of melted sugar, and covered with sugar by means of a series of short zigzag motions. Under an improved method of work the motions of carrying the candy center to the pot of melted sugar and moving it through the sirup were combined into a continuous curved movement. By this means the speed of production was increased by 27 per cent. The older workers, however, had used the original method for a number of years, and many of them were reluctant to change to the new method. With new employees the new method was markedly effective, and after a training period they were producing 88 per cent more than were comparable workers using the old method. It is apparent from this investigation that, even though a new method of work may be demonstrably superior to an old one, it may be difficult to establish it, owing to the conflict created with old well-established habits.

Opposite and Symmetrical Motions.—The position generally held in time-and-motion economy is that, when simultaneous movements of both arms are employed, the most effective procedure is to have the arms move in opposite and symmetrical directions. For example, if the worker is to reach to bins simultaneously with both hands in order to pick up parts for an assembly operation, it would be better to have the bins placed one to the right of the worker and the other to the left than to have both bins placed on either the right or the left side. Evidence cited for the validity of this motion is ordinarily obtained from investigations wherein differences other than merely the symmetry of the motions occur between the two methods of work. As yet, no valid conclusions can be drawn concerning the effectiveness of symmetrical as compared with asymmetrical motions. If coordination of the eyes and hands is required, as is likely to occur when the movements are made in picking up items, it would appear that symmetrical movements in opposite directions probably will be less effective than movements, whether symmetrical or not, permiting operation of the hands in contiguous positions. Further investigations with regard to such problems need to be done for a variety of different types of tasks before satisfactory conclusions can be drawn.

Barnes and Mundel have studied the effectiveness of simultaneous movements of both hands in relation to the direction of the movement.[23] In one of their investigations, subjects moved their hands away from and toward the body, the hands moving to specified points on the workbench as in reaching for objects in bins. The results, shown in Table 77, indicate that for the straight-line movements investigated the direction of the movement was of little or no importance insofar as speed of movement is concerned.

TABLE 77.—EFFECTIVENESS OF SIMULTANEOUS STRAIGHT-LINE MOVEMENTS OF BOTH HANDS IN CERTAIN OPPOSITE AND SYMMETRICAL DIRECTIONS

Angle between path of movement and plane parallel to chest, deg.	Relative time to complete 1 cycle of work	Relative error of movement
90	100	100
60	95	139
30	97	189
0	104	210

Grasping Materials.—The act of grasping or picking up small materials is characteristic of a wide variety of jobs. In clerical work there are papers, folders, clips, and the like to be picked up or held.

In the mechanical occupations fixtures, belts, washers, rivets, etc. are grasped and picked up preparatory to such acts as assembly and insertion. Owing to the fact that this simple operation is involved in so many different jobs it warrants special consideration.

The different ways in which an item can be picked up will vary with the nature, size, and structure of that item. The operation of grasping therefore cannot be thought of as one that can be performed in a few simple ways. It is beyond the scope of the present discussion to consider and evaluate all the different possible ways of grasping materials. Only the results of one investigation will be presented in order merely to indicate the types of findings obtainable from a systematic study.

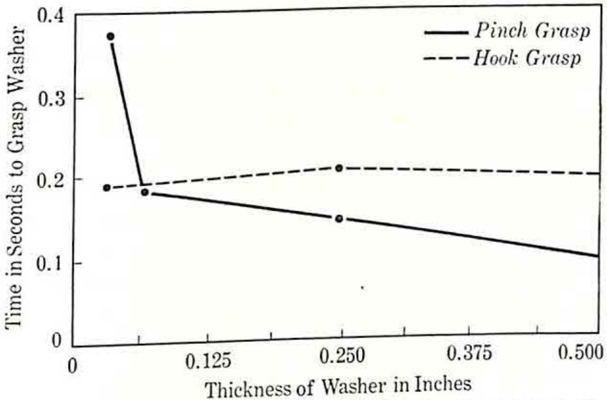


FIG. 30.—Time required to grasp washers in relation to the method of grasping and thickness of washer.

Barnes and Mundel compared two different methods of grasping and picking up small objects.[24] In their investigation the subjects picked up washers ranging in thickness from 1/32 to 1/2 in., the time required for grasping being noted. The methods of grasping evaluated were the pinch grasp, wherein the forefinger was placed on the edge of one side of the washer and the thumb on the edge of the opposite side, and the hook grasp, wherein the forefinger was placed on top of the washer and the thumb slightly under it. The results, given in Fig. 30, show that the superiority of one method compared to the other is a function of the size of the object. The speed with which the washers could be picked up when the hook grasp was employed did not vary significantly with the thickness of the object, but the pinch grasp was found to be much slower with thin washers and faster with thick ones

EFFECTIVE ARRANGEMENT OF THE WORKPLACE

Discussions of time-and-motion economy have stressed the importance of proper arrangement of the workplace as a means of increasing the speed of production.[25] A number of principles for optimal arrangements have been suggested, and in many instances significant savings have been effected by their application. To a large extent these principles are rule-of-thumb procedures and as such have not been subjected to scrutiny by scientific methods. In some cases the principles are simply statements of the obvious, or what should be obvious to anyone subjecting a particular workplace to systematic examination. It is in this sense that time-and-motion economy has been helpful in developing productive arrangements of workplaces. Rather than summarize here the rule-of-thumb principles of arrangement, we shall concern ourselves with the results of several investigations that are typical of the scientific approach to the pertinent problems of the workplace.

Pre-positioning of Tools.—By pre-positioning is meant the placing of a tool in such a position—as by means of a special holder—that it will be grasped in the manner in which it will be used. The familiar fountain pen desk set is an example of pre-positioning. The pen is slanted at the angle at which it is normally held in the hand for writing. Similarly on assembly jobs where a screw driver is constantly used it may be suspended just above the work by a coil spring attached to the upper part of the handle. With such an arrangement the worker does not have to search for the tool or even look up from the task in hand but needs simply to reach up, grasp the handle, which is in a constant and familiar position, and bring it down.

The effectiveness of pre-positioning tools has been demonstrated by Barnes and Mundel.[26] In one of their experiments a spiral-rachet screw driver was placed in the workplace in three different degrees of pre-positioning. In complete pre-positioning it was held over the workplace in the manner described in the previous paragraph. In partial pre-positioning it was held by a fixture on the bench to one side of the working space but in a position permitting ease of grasping in the manner in which the tool was used. Finally the screw driver was simply placed on the workbench without pre-positioning. The effectiveness of these various arrangements was gauged in terms of the speed with which bolts could be tightened by means of the screw driver. The number of bolts tightened per minute, when the tool was completely pre-positioned, was 24.0 per min., when partially pre-positioned, 19.5 per min., and, when not pre-positioned, 16.4 per min.

These findings clearly demonstrate the effectiveness of pre-positioning.

Types of Bins.—So many industrial jobs require the worker to pick up parts from containers preparatory to utilizing the parts in some way in connection with the job that it will be worth while to consider the effectiveness of different types of bins. Barnes and Mundel evaluated three different types.[27] One was a simple box-shaped bin with flat bottom that required the worker to dip his fingers into the contents in order to pick up a part. A second type of bin was the hopper-fed bin, which is similar to a box bin, except that the bottom is rounded and there is a constant feeding of materials, so that searching for a part is presumably reduced. The third type of bin was similar to the hopper bin, but with the added feature of a lip tray on one side so that the fingers could slide a part out to the edge of the tray for ease in grasping. The results given in Table 78 indicate that, insofar as time to grasp a part is concerned, the box bin and the hopper-fed bin show no consistent differences, whereas the bin with a tray is superior to both other types. Similar results were obtained when times for total cycles of work were taken.

TABLE 78.—TIMES REQUIRED TO SELECT AND GRASP A SMALL OBJECT FROM BIN AND DROP IT IN A HOLE

Operation	Box bin		Hopper-type bin		Bin with tray	
	Nuts	Screws	Nuts	Screws	Nuts	Screws
Time to grasp object, sec. . . .	0.392	0.321	0.377	0.352	0.234	0.279
Time for 1 cycle of work, sec.	0.888	0.968	0.826	0.940	0.696	0.857

The Working Area.—Discussions of effective arrangements of the workplace invariably stress what is known as the *maximum working area* and warn against the placement of bins, tools, and machine controls outside this area.[28] If a person is seated in an erect position at a workbench and describes arcs on the table top with his extended arms, the circumscribed area is called the maximum working area. Should the worker be required to reach outside this area, he must change his posture by bending his trunk either forward or to one side. To hold that all manual activity should be performed within these confines presupposes that any change in body posture is undesirable. However, a case might be made for just the opposite point of view. It can be argued that the use of the large trunk-muscle groups in bending the body, as in reaching, will effectively relieve the arm muscles of some of their activity. Over a long period of time therefore the productivity of the worker might be as great, or even greater, when both arm and trunk movements are sometimes involved than when arm movements alone are required. This question cannot be answered at the present time, in view of inadequate data. Certainly a set of definitive experiments are needed before it can be definitely concluded that all work should be performed within the so-called "maximum working area."

As might be expected, variation in location of the materials of work within the maximum working area produces changes in the speed of work. Barnes investigated the speed of movement of the arm away from and toward the body in relation to distance of movement, all distances being well within the maximum working area.[29] As will be seen in Table 79, the time to complete a movement increased as the length of the movement increased. It is important to note, however, that the time required for the larger movement was not increased in proportion to the increase in length of the movement. Rather it took relatively less time to make longer movements than shorter movements. In other words, speed of movement was greater for longer than for shorter movements. The results also showed that the percentage of time required for acceleration and deceleration of the movements did not vary systematically with the distance to be traversed, but that this time was relatively constant for different distances.

TABLE 79.—COMPARISON OF LONG AND SHORT MOVEMENTS OF THE HAND

Distance in.	Velocity, in. per sec.		Per cent of distance required for acceleration of movement		Per cent of distance required for deceleration of movement	
	Toward body	Away from body	Toward body	Away from body	Toward body	Away from body
5	12	11	35	34	35	36
10	20	20	35	37	37	35
15	25	26	34	39	39	33

In another part of the experiment the subject reached for a part that he carried back to the work space for insertion into a fixture. In this experiment the distances investigated were up to 24 in., which is practically the outer limit of the working area. The results obtained were similar to those of the first experiment; *i.e.*, increasing the length of the movement required longer time for the movement, but it was associated with increased speed of movement. As shown in Table 80.

even stretching the arm to the outer limit of the working area gave no excessive increase in time.

TABLE 80.—COMPARISON OF LONG AND SHORT MOVEMENTS OF THE HAND IN AN INDUSTRIAL OPERATION

Distance between bin and fixture, in.	Time to move empty hand from fixture to bin, min.	Time to carry part from bin to fixture, min.
8	0.0037	0.0045
16	0.0044	0.0064
24	0.0058	0.0070

EFFECTIVE DESIGN OF TOOLS AND EQUIPMENT

The design of tools and equipment has largely fallen to the engineer. To some extent this has been due to a lack of interest on the part of psychologists, but to a large extent it is due to the fact that the design of tools and equipment has been dictated by mechanical and financial considerations rather than by human factors. There is no machine so automatic and so perfect that no human control or direction is required. Indeed there is something to be said for the point of view that tools and machines are simply mechanical extensions of the human organism, created for the purpose of making more rapid, more accurate, or stronger responses. Viewed in this light it is apparent that the effectiveness of industrial equipment will be a direct function of the degree to which the human factor is taken into account. The mechanical and financial aspects, of course, must be taken into consideration, but it is also true that various savings and benefits will be obtained by designing the tools and equipment in terms of the characteristics of the individual who will use them in industrial work.

It cannot be assumed that simply because one type of equipment permits greater mechanical advantage or speed for the operator, that it is therefore superior. Such an approach is purely inferential, and such a conclusion needs empirical verification. Thus Barnes and Mundel were not satisfied that a power-driven screw driver would yield greater speed of work than a completely hand-driven tool.[30] They actually set persons to work tightening screws with different types of screw drivers and found experimentally that the power-driven tool required about 25 per cent less time for the operation than the best hand-driven tool.

The dangers of a priori conclusions can be illustrated in the case of aircraft controls. Originally the elevators, rudders, and other controls were operated completely by arm and leg movements of the pilot. With larger aircraft and for operations requiring violent maneuvers it became apparent that the strength and endurance of the pilot were insufficient. Mechanical and hydraulic booster systems that provided the extra needed force were then introduced.

There are now further problems being introduced with even larger aircraft, and with aircraft whose speeds are so great that even a booster system might be inadequate. The obvious suggestion would be to have the pilot simply press buttons, push switches, and twist knobs, activating appropriate machinery that in turn would move the elevators, rudders, etc. Before this conclusion can be accepted, however, it must be ascertained whether or not anything is lost by a completely automatic system. The pilot gets certain information from the "feel" of the controls, their resistance to manipulation and their tendencies to move from the influence of external forces. The problem of the importance of the "feel" of controls for the piloting of aircraft, particularly under difficult or unusual situations, is far from being solved. Under such circumstances therefore it would be unwise to adopt a completely automatic control system without testing it under a wide variety of operational conditions.

In view of the importance of the human factor in the design of tools and equipment the concern here will be with the psychological aspects rather than the mechanical aspects of the problem. Again a complete survey of all possibilities will not be made, but consideration will be given to certain typical areas.

Design in Relation to Human Capacities.—Those persons whose job requires them to use tools or machines in actual operations are perpetually amazed at their inadequacies insofar as human capacities are concerned. The damnations directed by workers at their tools and machines can be taken as signs of more than the workers' personal deficiencies. Such verbalization may be a sign that the equipment is inadequate. Consider how many machines have all the controls on the left-hand side. Consider how many wrenches have handles so short that even a Sandow could not cinch a bolt with them. There are all too many instances of tools and equipment designed with utter disregard for the capacities of the individuals who are called upon to operate them.

The various motor and perceptual capacities of human beings are the basic data that should be considered in the design of any equipment. They are the factors that should enter into the determination of the placement, form, and mode of operation of controls, dials, indicators, and other parts of equipment with which the worker is concerned. If under ordinary circumstances a typical worker in pulling a lever does so with a force of about 70 lb., then the lever on a machine should not require a force of more than 70 lb. to pull it. If it takes 0.3 sec. for a worker to press a control button in response to a warning bell, then it is pointless to design a machine so accurately that it starts or stops in less time. If a worker cannot read figures $\frac{1}{8}$ in. high on a dial 10 ft. away from him, then the figures should be made larger. Normative data with respect to different motor and perceptual capacities of the worker provide guides for the designer of tools and equipment.[31] Knowledge of the range of individual differences in strength of pull, reaction time to auditory stimuli, visual acuity, etc., is important. When such information is not available, specific investigations need to be undertaken to collect it. In the following paragraphs several examples will be given of the design of tools and equipment in relation to human capacities.

The common typewriter is an instance of a most flagrant deviation from this principle. On the basis of tests of tapping and analyses of the errors made by the different fingers, the ability of each finger for typing was estimated.[32] In the top row of Table 81 the relative amount of work each finger and hand should do—the ideal load—is given. These figures may be contrasted with those in the second row giving the load required by the arrangement of the keys on the present typewriter. From this table it can clearly be seen that the present typewriter is inferior in the distribution of work it assigns to each finger and hand. For example, the fourth finger of the right hand only does one-third of the work that it should, while the second finger of the left hand does over 50 per cent more work than it should. The

TABLE 81.—A COMPARISON OF THE LOAD CARRIED BY EACH FINGER AND HAND ON THE IDEAL AND THE PRESENT TYPEWRITER KEYBOARDS

Kind of load	Left-hand load, per cent					Right-hand load, per cent					Total both hands, per cent
	Finger				Total	Finger				Total	
	4	3	2	1		1	2	3	4		
Ideal load	10.8	11.4	12.3	13.0	47.5	13.9	13.9	12.5	12.2	52.5	100
Present load	10.2	8.3	18.9	19.4	56.8	18.8	8.1	12.6	3.7	43.2	100
Ratio of present to ideal	94	73	154	149	120	135	58	101	30	82	

left hand does one-fifth more work than it should, and the right one-fifth less. On the basis of studies such as these, keyboards yielding maximal mechanical advantage have been constructed. Tests made on one such typewriter revealed its advantage in terms of reducing the time necessary for learning to attain a given level of typing speed, faster speed of typing, fewer errors, and less work decrement.[33]

In a study of the optimal shape for heavy screw-driver handles, effectiveness was measured in terms of the force with which screw drivers could be turned, and in terms of the distance a weight could be lifted by turning a screw for ½ a min.[34] Handles with a uniform diameter throughout their length were found to be about 20 per cent more effective than those in which the diameter of the lower part of the handle was less than that of the upper part. Tests of the optimal shape of crank handles have been made where effectiveness was measured in terms of the reduction of the strength of grip of the operator after turning the crank at uniform speeds against known loads.[35] Those handles which had a uniform diameter, with a slight indentation near one end for the forefinger, were found to be most effective. The general conclusion from studies such as these is that, with tools and equipment used in work where the hand carries a heavy load, maximum effectiveness results when the handle is shaped so that the average pressure per unit area of hand surface is at a minimum. Hence those handles which permit a large contact surface with the palm of the hand are the best.

The utility of this type of handle, however, does not hold for every task. Studies of screw drivers used for light work suggest a different optimal shape; the diameter of the upper part of the handle should be larger than the diameter of the lower part.[36] Such a shape permits rapid insertion of the screw by rotating the lower part of the screw-driver handle between the thumb and second finger, with a final tightening by use of the increased leverage provided by the large diameter of the top portion. The mere fact that the same general type of tool is used in different tasks does not necessarily mean that the design should be the same.

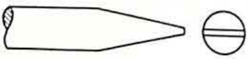
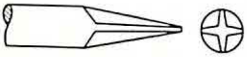
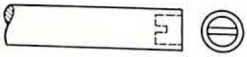
The movement of levers, crossbars, and handwheels has also been studied in a similar connection.[37] In these investigations effectiveness was measured in terms of the amount of force that could be exerted by the subject. The study of levers will suffice as an example. Levers that were either pulled or pushed were tested in three positions relative to the operator and at three different heights from the floor. The results indicated that neither position, direction of movement, nor height, alone, was the determining variable in producing effectiveness, but rather that there were optimal combinations of all three. This study illustrates the necessity for investigating all aspects of a work situation before deciding upon the best type of movement.

Design to Minimize Probability of Human Error.—In discussions of highway design with regard to safety problems it has been said that the most effective approach is to develop a highway whereon the likelihood of the automobile driver getting into difficulties is at a minimum. In other words a highway should be so constructed as to reduce all potential sources of friction in the flow of traffic. Human error is reduced by eliminating those situations where the individual has an opportunity of making an error. This point of view can be carried directly over to the field of design of tools and equipment. The performance of an individual is never perfectly consistent. If possible inaccurate responses are uncovered and recognized, and steps are taken to obviate the possibility of their occurrence, then performance will be greatly improved.

Accidents, of course, are the most striking results of human error in industry. In a later chapter concerned with accidents it will be pointed out that the analysis of workers' errors is an important step in the development of adequate safety measures. Errors, however, may lead to a wide variety of other types of detrimental results. Errors may bring about poorer quality of production or reduced speed of production. A misread gauge may cause damage to equipment or result in a faulty product. Too strong pressure on the control lever of a drill press may cause the bit to break or the hole to be drilled out of round. Again, the interest is in the various motor and perceptual responses of the individual, but here the concern is with their possible inadequacies or inaccuracies. If tools and machines are designed so that inadequate motor and perceptual responses are minimized, then work involving these tools and machines will be more effective.

A common example of human error leading to ineffective performance is the case of tightening screws with a screw driver. In tightening a screw the individual should keep the tool in direct line with the screw. If the operator tilts the screw driver out of this direct line, the bit is apt to slip from the slot in the screw, resulting in possible damage to fingers and materials, and slower production since the bit must again be set in the slot to complete the task. It seems clear that a screw driver designed to minimize or eliminate this slippage would be superior to the ordinary type of tool. Barnes and Mundel evaluated two different screw drivers designed to minimize slipping of this sort and compared them with the ordinary screw driver.[38] The types of bits they studied and their findings are given in Table 82. From these results it can be seen that the use of screw drivers that reduce the slipping of the bit from the screw head results in higher levels of production. Although the effectiveness of these bits in other respects was not investigated, it is likely that they also would reduce damage to fingers and to materials.

TABLE 82.—EFFECTIVENESS OF SCREWDRIVERS WITH DIFFERENT TYPES OF BITS

Type of bit	Number of screws tightened per min.	
	With screw already inserted	With screw started by operator
	10.7	5.7
	11.5	6.3
	12.1	6.6

Design in Accordance with Good Workplace Arrangements.—An industrial machine is likely to be the workplace of the employee. He sits or stands at his machine feeding it materials or operating its controls. Obviously therefore any findings relative to effective arrangements of workplaces are directly applicable in the design of machines. Legros and Weston investigated the construction and operation of a wide variety of industrial machines.[39] They noted a number of deficiencies with respect to machines as workplaces. In many cases the machines required awkward and tiring postures and movements on the part of the workers. In some instances the machine obstructed the vision of the operator, whereas, in others, parts of the machine that had to be observed moved through too large an angle of vision. Furthermore these investigators found workplace problems specific to the machinery; in some cases vibration, shock, and noise reduced the effectiveness of the worker.

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CHAPTER XII

PSYCHOLOGICAL PRINCIPLES APPLIED TO PROBLEMS OF INDUSTRIAL TRAINING

Seldom in the contractual relations between employer and employee is an express statement made concerning the obligations of either in reference to the problems of training. Certain unwritten understandings, however, that are accepted in varying degrees by the two groups have gradually developed. There is an unwritten law that the employer is obligated to instruct the worker in the required responses of the job—to assist him in gaining the knowledge and developing the skill that will enable him to produce at an acceptable level of efficiency. Along with this condition there is the obligation on the part of the worker to learn, to accept instruction from the employer, and to strive to develop and perfect the necessary techniques and skills that will guarantee a high level of productivity.

Today progressive firms do not leave the training of their employees to chance but organize comprehensive training programs covering many different phases of the operations. Nevertheless the objectives of these programs in general have been narrowly conceived, centering the training almost wholly on the end of immediately increasing production. Certainly greater production is to be desired, but solving training problems in terms of immediate goals of production has meant a disregard of long-range problems, whose solution through training is important, and whose solution will eventually also bring higher levels of productivity.

Training in industry must be viewed in its broader outlines, as serving both employer and employee in other ways than simply increasing the number of units produced during a day's work. It is not a field in which the employer and employee are squared off in opposition with each other but rather one in which mutual contribution is essential, and in which the returns are conceived as benefiting one quite as much as the other.

IMPORTANT EMPHASES IN TRAINING

Broadening the Base of Training.—No arguments need to be presented to justify training programs in industry. Training is an accepted, albeit a somewhat slowly developing, part of nearly all personnel programs. Arguments need to be concerned with the extent of training in terms of subject matter, the nature of training procedures, the numbers of persons to be trained, and the measurement, evaluation and improvement of training results.

One of the newer emphases, and one that should receive more attention by the employer, is the need of training the worker in phases other than those of a technical nature directly related to success on the job. The past has seen too great a concern for these technical phases with insufficient concern for, or complete disregard of, certain primary human phases. The worker as a human being is more than a mere machine. Skill is accepted as of primary concern, but it is far from being a sole determiner of the worker's performance. Attitudinal aspects may outweigh skill.

Emphases in past training programs, almost always restricted to skills, must be enlarged to incorporate the development of less tangible types of behavior such as initiative, leadership, desire to improve and progress, acceptance of responsibility, etc. Training should extend beyond habits of work to attitudes concerning economic and business policies, which may be related to the individual's performance on his job. The degree of skill attained and the maintenance of high levels of skill over a long period of time are closely bound up with incentives, interests, satisfactions from growth and improvement, and similar factors stemming from the varied phases of the worker's life.

Emphasis upon Worker Adjustment.—The new emphasis should center its focus on worker adjustment. It should be directed toward the adjustment of the worker within the ranges of tasks offered by the organization employing him. The center of attention is then the worker's adjustment to his work and not production per se. This broader point of view encourages the consideration of factors arising in nonworking environments such as in social and family living. It considers the individual not only as a worker but also as a person and is concerned with all his major personal adjustments, not merely those which spatially are localized on the properties of the organization employing him. The new emphasis goes beyond the development of skill to the problem of the conservation of skill and to the avoidance of waste of human productive capacity. The new conception maintains that the job must come within the psychophysiological tolerance of the individual if the greatest returns to both employer and employee are to be achieved.

Emphasis upon Individualized Training.—With this wider envisagement of the function of training, a division in the purposes of training programs can be made between those problems which specifically concern knowledge and skill of the job and which require an intensive development of the worker in restricted fields, and the problems of a more general nature that extend into whatever fields are concerned with the worker's adjustments, regardless of any direct relationship they may have with job performance. Within the latter more extensive type of training there must develop an individualized approach—a concern with the problems of each worker as an individual. In many instances the actual training given may be one of group instruction, but certainly the isolation of the problems needing attention, and much of the training necessary in the solution of these problems, will require that the worker be dealt with as an individual.

Emphasis upon Continuous Training.—A further topic, which will receive greater attention as training is more generally conceived in its wider implications, is the continuous nature of training. Training is a continuous function for every worker. If there is one stable characteristic of industry today, it is its changeableness. Changes in supply and demand, and in growth and progress resulting from technical advancements, are the two greatest hazards to a continued static existence on the part of the individual worker. Vigilance as exercised by management in keeping abreast of industrial progress must be developed in the worker, so that he too may keep abreast of the changes that directly concern his working effectiveness. To do this requires that training go beyond the initial orientation and practice on the job given the worker at the beginning of employment. Furthermore, if factors other than those stemming from the working environment are to be an essential part of training, the training must of necessity be continuous. Certainly the time never arrives when an individual can achieve no further increments of improvement, and consequently a stage is never reached when training programs can be dispensed with as having lost their usefulness.

SOME FUNDAMENTAL QUESTIONS ABOUT TRAINING

Certain major questions arise whenever a program of training comes up for consideration. A comprehensive discussion of these questions is beyond the scope of this book, but mention should be made of certain problems that require solution in setting up any training program.

Who Should Be Trained?—This question has two meanings. When interpreted broadly, it is concerned with what classes or levels of employees are to be trained. From the point of view already suggested in the preceding topics, the expected answer is that everyone in an organization from the top executive to the least skilled worker is eligible and should be exposed to training. No case will be made here that the president and vice-president of a concern should routinely attend classes, although this is not so remote as it appears at first. Top executives are undergoing informal training of one kind or another a great deal of the time, most of which is voluntarily sought.

A case should be made, however, for stressing the need of a wider coverage of the employed group than is envisaged in most training programs today. Many a willing but inefficient worker when given some individual attention shows remarkable improvement. For many jobs plugging individuals are more desirable than brilliant but less persistent workers. The latter bright but dronish individuals, however, are not to be denied training. Their schooling must be in the direction of getting them to set up goals and incentives, from the attainment of which their particular qualifications and abilities will be developed. They need to be trained in initiative rather than in skill. When the training includes problems of motivation, of personal development and ambition, factors of family and home security, and similar phases of adjustment, then everyone within an organization must be considered eligible and should receive training that will meet his particular needs.

When interpreted in another sense, the answer to the question of who is to be trained is directly conditioned by the purposes in view. It should be preceded by the question: For what purpose is training needed? If some particular problem directly related to job performance is concerned, then the individuals eligible for training should be those who have the qualifications in experience, traits, and aptitudes that will enable them, after training, to perform the work desired at an acceptable level of effectiveness. This immediately introduces a problem in selection procedures, for individuals selected for training should have the required experiences, traits, and aptitudes to make the training a profitable undertaking. Some valid standardized procedure should be in force in the selection of all trainees, but obviously, as the job to be learned entails more and more individual responsibility, judgment, and initiative, the importance of correct selection procedures increases correspondingly. Traditional methods of selecting trainees need reexamination and evaluation. Their long acceptance by management should not be the sole consideration for their adoption.

Who Is to Do the Training?—The selection of the appropriate persons to conduct the training is not easy. The trend of the past has been to select as teachers those who have had a superior record of performance on the job. This criterion by itself is insufficient and should be supplemented by such qualifications as concern the teaching ability of the trainer. The time-honored custom of merely assigning new workers to learn under older reliable workers ignores such qualifications. Teaching is a specialty in itself for which there are definite traits, interests, and abilities, which are to be found in only a small proportion of the average working population.

If the worker after being made an instructor continues to work under the combination of interests, drives, and sets that have made him a top producer, he will consider the added task of teaching as an extra task that should be reduced to a minimum. Such an attitude is not conducive to good teaching and will result in the new worker being neglected and inefficiently trained. Certainly such qualities as interest in other people, ability to understand the difficulties of inexperienced workers, patience in the correction of others' faults, and ability to inspire and motivate the trainee to do his best are quite as important as being able to perform the work itself. Such personality factors should be given weight in the selection of any worker who is to be given the responsibility of training others.

What Is the Function of Management in Training?—There is no single answer that is adequate for this question. Some general statements, however, can be made that might focus attention on problems needing further consideration by those concerned with organizing training programs. It can be stated categorically that management's contribution does not begin or end at any point; it is as continuous as the need for training is continuous. It enters at every phase of training from the beginning to the end and extends past the cessation of any formalized program to later periods when checkups and evaluation are in order.

In the past, management has sometimes seemed to be opposed to training rather than in favor of it. Certainly only infrequently has management utilized all possible psychological aids for realizing the most rapid learning and the greatest retention of the materials and skills being taught. Such practices as assigning the responsibility for training to an already overworked executive who possesses no particular inclination for it, making available only worn-out and broken-down machines for the learners to practice on, limiting the training time of the worker to a period so short that only the minimum essentials can be taught and not allowing sufficient time to bring these to a high level of perfection, and assigning space that in size and location is not conducive to the concentration and application that the new worker is expected to manifest can hardly be considered indicative of a keen and intense interest on the part of management in the training problems of its workers.

Management has a large stake in the training of its employees, a stake that may extend temporally over many years of time and have immediate and definite effects upon production and upon profits. It is then to management's own interests to take advantage of every psychological principle conducive both to the rapid learning and the long retention of the materials and skills taught the workers and to the over-all adjustment of the worker on his job.

How Should Training Be Conducted?—It is not the intention to consider here the many aspects of this question but rather to point up one of the most important psychological steps that management should take to enlist the full cooperation of its workers in organizing and conducting training programs.[1]

There has been a tendency, now happily becoming outmoded, to establish training programs on the basis of authority. To the new employee this has seemed acceptable, but when the need has arisen for further training of the older workers, management has commonly utilized the same attack—the program has been presented to the employees by fiat. Often the worker has not been made aware of the need for the training; his part in the whole scheme has never been described to him. Inasmuch as he is the one who has to undergo the training, he should be made aware of its purposes. Such comments heard among the workers as "the boss wants us to go to school again" are indicative of a lack of interest and cooperation very likely stemming from ignorance on their part of the purposes for which the training program was established.

Little can be achieved by authority, preaching, or by appeal to the emotions. What the worker wants are facts, and time to think through the facts. His interest, knowledge, and enthusiasm should contribute to the program rather than be stifled by having a completely cut-and-dried schedule thrust at him from "on high." Worker participation in all phases of training should be considered absolutely essential. An organization encouraging individual initiative, individual participation, individual accomplishment, and individual reward has laid a psychologically sound basis that will go far toward making any training program a success.

The workers' stake in industry has always been enormous, but their ability to contribute to its progress and to control in some degree its advancement has only recently attained sizable proportion. Training offers a common ground where the cooperation and mutual trust of both employer and employee can be exploited for the good of both. It offers to the employer a means for fostering and encouraging the workers' participation in solving current problems that continually arise within industrial progress. In addition such employee participation establishes the necessary attitudes, interests, and drives that are so essential to a rapid development of knowledge and skill and their later efficient utilization on the job.

RESULTS TO BE EXPECTED FROM TRAINING PROGRAMS

Some Criteria Reflecting Change.—The improvement resulting from adequately conducted training programs can be looked for in almost every situation involving worker performance. Regardless of what measure is used for evaluating performance, an increase in effectiveness is usually to be found. This improvement is not always manifest at the moment of termination of the formal instruction. The subtle effects resulting from changes in attitudes, motives, and interests sometime appear only after several months. A review of several reports of training programs conducted in industry revealed changes in one or more of the following:

Increased worker satisfaction
Higher level of morale
Increased interest in the work
Greater cooperation between management and the workers
Reduction in sick time
Improved safety records
Increased level of output
Reduced variation in output
Decrease in labor turnover

An Example of the Results of Training.—A typical example, reporting the improvement in skill resulting from a planned, intensive training program, is found in a study by Langley and Edwards.[2] They demonstrated that it was entirely feasible to improve significantly the proficiency of so-called "inefficient" workers. In a task primarily involving hand and finger movements they found that less than 15 per cent of the trainees failed to attain the high standard that had been set as a goal for all workers. Even these slower workers showed significant improvement, and their failure to attain the goal was attributed not to lack of ability but to lack of sufficient motivation. The training program primarily was directed toward explanation and practice in skilled movements, and no concerted effort was made to discover and instruct the workers in those problems which revolved around personal interests and motives. It is very likely that a more intensive effort to analyze and assist in such phases would have eventually brought these slower workers to an even higher level of proficiency.

Langley and Edwards have reported actual percentages of improvement shown by the trainee and have made comparisons between formally trained and untrained groups, a type of scientific approach all too infrequent in industrial reports of training programs. A sample comparison will indicate the general superiority of the formal training method over the older method of putting the worker on the job and letting him learn in a hit-or-miss fashion. They report that the group receiving formal training reached a level of proficiency in 14 weeks that was attained by the informally trained workers only after a period of 3 years. In addition to an increase in hourly output of about 50 per cent, the authors report that there was no resentment on the part of the workers in being trained, that absenteeism almost vanished, that labor costs were materially reduced, that labor turnover was greatly reduced, and that the operators directly benefited from an increase in earnings. Surely these results amply justify the authors' painstaking efforts which went into the formulation of their standardized and systematic training program.

APPLICABILITY OF EDUCATIONAL PRACTICES TO INDUSTRIAL TRAINING PROBLEMS

To get the most efficient results from a training program, it is necessary to utilize sound psychological principles of instruction and of learning. This dictum needs no special emphasis, for, as in all fields of endeavor, there are in training effective and ineffective ways of accomplishing the desired ends. There may be some question, however, as to just which pedagogical practices developed in the schoolroom and laboratory are applicable in the situations found in industry. It is beyond the scope of this book to present the evidence that has accumulated for and against the usefulness of classroom practices in industrial training, but a description will be given of the fundamental logic that should serve as a guide in making generalizations from the school to the factory.

The Nature of Generalization.—To begin with, consideration should be given to the nature of scientific generalization. Simply stated, a generalization is an attempt to take a fact or relationship that has been discovered or observed in one situation and apply it to another situation that in some characteristics differs from the first. Many factors condition the accuracy of generalization, the two most important of which are, first, the accuracy of the original observation and its description, and, secondly, the degree to which the causal factors present in the original situation also operate in the second situation. When considering causal factors, interest is directed primarily to those causes known to be important in producing the specific results about which the generalization is made.

Similarities and Differences.—For present purposes, in considering the application of schoolroom practices to industrial training, there is little need to examine the first point. For the most part it is safe to assume that the reports of classroom and laboratory findings on factors influencing learning and retention are true for the situations described. It is of far greater import to examine the second condition, which is concerned with the similarities and differences between the two situations. The problem is not a simple one because of the number and complexity of the factors operating to determine individual performance in the two situations. Certainly it cannot be gainsaid that there are a large number of causal conditions common to both school and factory. Many of the aptitudes, abilities, interests, motives, desires, and traits requisite to the individual learning from books and projects in the classroom and laboratory are the same as those of the novice worker at the factory bench or at the desk in the office. The converse of this, however, is also true; there are many factors in the school not to be found in the factory. The only rational solution is to consider the given specific situation for which training is needed in industry and learn to what extent it agrees, in terms of important causal conditions, with specific classroom and laboratory situations that have been studied.

No profit is had from generalizations that endeavor to encompass all or almost all possible situations. It is not true that all findings of the classroom are applicable to industrial training; neither is it true that there is little profit afforded the industrial trainer from the results of experiments conducted on school children. The truth lies in between these two views and is based on the generalization that, whenever the industrial situation corresponds in its important causal factors with the conditions of the classroom, the findings of the latter have a high probability of being true for the former.

The Tentative Nature of Generalizations.—The use of the word *probability* in this connection indicates the tentative nature of any generalization that might be made. It is not possible to be absolutely certain that a given classroom or laboratory finding will hold for a factory or office type of learning situation. What is possible is to infer a probability that the finding is likely to be applicable. Whenever a generalization is made for the first time about some factor influencing learning as studied under school conditions, it is always best to accept it on a tentative basis. As evidence accumulates from industrial studies to substantiate the generalization, increased confidence can be placed in it. In the absence of any knowledge already obtained from factory conditions of training it seems necessary to accept tentatively the findings available from other sources. A safe procedure then is to put into operation in industrial training all possible psychological principles that have been found to facilitate learning and retention in the schoolroom and to accept them as working hypotheses until they are proved sound, or until a better set of postulates is discovered from the industrial situation itself.

Examples of Generalization.—Before reviewing some of these psychological principles, two examples of generalizations will be presented. One finding from studies on learning in the schoolroom is that individualized instruction produces the most efficient learning.[3] In generalizing to industrial training the postulate can be made that better results will be obtained under individualized instruction than under group instruction. However, as stated in the foregoing paragraphs, the specific conditions of the classroom and industrial situations must be compared. Only one such condition need be considered. Individualized instruction is superior to mass instruction when the learning problems are difficult and many sources of error and confusion are possible. Now this principle very likely holds true in industrial training when the tasks to be learned are very complicated and contain many and various types of pitfalls, or when the tasks vary from individual to individual as in the treatment of problems of home and social living.

A further finding from the academic laboratory is that simple repetitive tasks are conducive to monotony and boredom when they offer no challenge to an individual's ability. As a result the rate of learning is decreased. Such a finding can be usefully applied in industrial training. The probability is high that certain phases of the learning of a skill will be repetitive and thus tend toward monotony. If these phases form the major part of the job, then certain steps should be taken previous to training to eliminate individuals with high ability. Despite the fact that such individuals could successfully perform on the job, they are not likely to persist long in the face of the boredom they would experience. If the repetitive phases are only a minor part of a more complex set of factors, then steps should be taken during the learning of these phases to keep the trainees at a high level of motivation in order to avoid any drop in the rate of learning. Certainly in the absence of any further knowledge the finding from the laboratory can be accepted tentatively, and the training program set up in such a way as to take advantage of it. In the following pages other psychological principles of importance in industrial training will be discussed.

THE NATURE OF ADJUSTMENT[4]

Adjustment—The Objective of Training.—Industrial training is usually defined as the process by which, through some form of instruction, the necessary responses for correctly performing a job are developed. Sometimes the phrases "correct habits of work" or "correct habits of thought and action" are utilized. For the most part the definition is concerned wholly with responses demanded by the job, and the emphasis is upon improvement in the worker's accuracy and speed in order that he can produce more work.

The concept of the human being as a machine, which can be set into motion on the job at the beginning of the day and turned off again at the close of the day, has been an important factor in establishing this interpretation of training. The profit motive, which probably gave rise to the concept of the "worker as a machine," also has contributed to this interpretation.

As already suggested in this chapter, a sounder interpretation of training is to conceive of it as a means of adjusting the worker in the working environment in such a way as to bring about the greatest returns to both the worker and the organization employing him. In order to adjust the worker in the working environment it is implied that it may be necessary to consider factors originating in nonworking environments, but which nevertheless have significant influence on the worker's productivity.[5] The concept of the "adjustment of the worker on the job" is then the focal point of all training. It will be found that training directed to this end will contribute to both parties concerned: to the company in increased production and greater potential growth, and to the worker in greater income and in increased satisfaction from his personal security and achievements.

The Individual an Integrated Whole.—In considering the concept of worker adjustment it is necessary to think of the individual as an integrated whole, as a single organism, possessing many complexly interacting aptitudes, abilities, interests, traits, motives, desires, and aversions.[6] The older industrialists considered the worker as though he were several unrelated, noninteracting systems of response. He was "compartmentalized," and each compartment was interpreted as a relatively separate and independent system. Under this interpretation there was little interchange between the working compartment and the social, home, recreational, religious, or other compartments. It was almost as if there was a "working man" separate and distinct from the man as seen in action in other types of environment.

Later in the history of industrial development, progressive employers realized that the worker's production was influenced by many factors arising outside the working environment. Even after recognizing this fact, however, they did nothing to assist the worker, considering that such other influences were outside their jurisdiction or authority. This was a short-sighted policy and one which today is altogether too prevalent. If the worker is to be adjusted to the demands of his work, it is necessary that all factors influencing his working proficiency be taken into consideration.

The Multiphasic Nature of Adjustment.—A further aspect of adjustment that needs consideration is the multiphasic nature of the adjustment that any job requires of the individual. All too frequently job demands or requirements are reduced to a psychological simplicity both unreal and irrational. For example, in assembly work at a bench the job may be described as merely requiring the individual to make simple grasping and placing movements with the hands and arms. Assuming this as true, it is far from a description of the psychological and physiological demands of the work. From a physiological standpoint the nature of the coordinations involved, the rate of the movements, the repetitive nature of the responses, the rate of onset of work decrement, and similar factors must be studied not solely from the point of view of the production rate but also from the point of view of the worker's motor aptitude and his physiological tolerance for the reactions.

Furthermore the psychological phases of the job are omitted.[7] Factors of social development, personal motivation, satisfaction from individual achievement, possibilities for further growth and advancement, and ability to withstand the monotony involved may profoundly affect working proficiency. Even the simplest unskilled tasks may elicit many different expressions from the worker and involve very complex interactions among different systems of responses. The job must come within the psychological tolerance limits of the worker

The worker's adjustment, then, must be conceived as multiphasic in nature, involving aptitudes, abilities, interests, motives, traits, desires, and aversions in different interacting combinations.

The Dynamic Nature of Adjustment.—The multitudinous factors conditioning human behavior are continuously undergoing change, and this is no less true in industrial situations than elsewhere. No worker remains adjusted when static. The human trait of desiring to grow, improve, and progress is not restricted to top management. Merely from the constantly changing conditions of normal living alone, the individual is required to change his behavior continuously.[8] It is obvious then that to remain adjusted requires change. It is at this point that training makes its contribution, for it can offer procedures of diagnosis and remedy that will go far in the direction of enabling the worker to maintain a satisfactory adjustment despite the continually changing stimulations to which he must react.

Signs of Maladjustment.—Maladjustment manifests itself in many and varied forms, but there are a few signs that are almost certain indicators that the individual is experiencing difficulty. Large fluctuations in output from day to day are usually symptomatic. When there are several workers performing the same task, a comparison can be made of their daily or weekly fluctuations in output. When there is only one individual on a given job his current performance can be compared with his performance during an earlier period. In both situations there must be some standard against which to evaluate the current output of the worker. When fluctuations in output are far greater than the standard, some attention should be given the individual. It is the large fluctuations, which seem to be chronic in form, that are symptomatic of some underlying disturbance in the worker's experience. Fluctuations in output, speed, quality, and other work characteristics will always be present. There will always be variations attributable to transitory factors, but these usually are small in amount and should disappear within a few days at most.

Intrusion of worry and anxiety on the job are other signals to watch for. Frequently when home conditions are not just right, the worker will manifest intense emotion and anxiety in his attitude and conversation with fellow employees. By the time this occurs there is usually sufficient reason for thinking that the individual already has experienced some difficulty with which he is struggling. Lapses of attention while working, lowered physical status, and excessive absenteeism are other signs that the adjustment of the worker may need attention.

Mechanisms of Adjustment.—Some of the adjustive mechanisms available and utilized to effect and maintain equilibrium should be briefly considered.[9] Certain ones have already been mentioned. Worry, anxiety, and other forms of emotional reaction are attempts of the individual to deal with his problems. Psychologically they are ineffective responses and are to be avoided as adaptive mechanisms. Actually these reactions aggravate the maladjustment. They seldom result in behavior that removes the cause of the difficulty, and as a result no satisfactory solution is achieved; yet they persist and are very costly in terms of expenditure of energy. In the absence of other modes of attack the individual continues to use them and thus remains unadjusted.

Habit.[10]—Habits, because of their stability, are often resorted to when personal difficulties arise. Sometimes, because of their inflexibility and because they have been established as a response to routine forms of stimulation, habits are not effective in adjusting the individual to changed conditions. That is, the individual may never before have been exposed to the type of stimuli giving rise to his maladjustment and therefore has never had the opportunity or practice necessary for adapting his habitual modes of behavior to these new stimuli. Frequently the failure to adjust is referred to as a "breakdown of habit mechanisms." Habits, however, may prove extremely useful in times of stress. There are many reactions in the form of both skills and attitudes established on the job that are conducive to steady, unruffled job performance. Made into strong habitual responses, these habits frequently continue to stabilize performance on the job when emotional problems from other sources assume troublesome proportions.

One characteristic of habit mechanisms that limits their usefulness in times of maladjustment is their resistance to change. Appeal to habit comes easy to the individual, it requires a minimum expenditure of energy, it runs its course without requiring constant supervision. Consequently in competition with new forms of response it frequently comes out as the winner, and the individual is satisfied to plod along in the old habitual rut. In a world of change, where stability and composure can be maintained only by a continual variation in response, habit may become a psychological handicap to the individual. It is not impossible, however, to train out habits. The point of view that you can't teach an old dog new tricks is not psychologically sound. It may be difficult to change habit mechanisms that are handicapping the worker in his adjustments, but with the use of sound psychological procedures it can be done.

Rational Analysis.—The approach to problems of adjustment that offers the greatest promise is the rational approach of psychological analysis. This is the method of science applied to the intangible problems of the individual. It is not a new technique but a rather unfamiliar one because so many individuals have never made use of it in their solutions of personal problems. It consists of learning and understanding the factors causing a maladjustment; of finding out possible ways of eliminating, modifying, or overcoming these factors; of choosing that way which comes within the scope of the individual's talents; of setting up a procedure or regimen that will accomplish the desired changes; and finally of supplying the conditions necessary for the execution of the procedures.[11] Although it might seem simple, the method is rather difficult to apply. It requires a great deal of thought, an impersonal approach, and a recognition of personal limitations, and it requires that aims and ideals be brought within the range of reality and realization. None of these steps comes particularly easy for most individuals. Despite its requirements the method has proved superior to all others in the resolution of problems of maladjustment.

It must be conceded that the worker will need assistance, and it is at this point that training again assumes its rightful and vital role. The use of reflective thought and analysis in solving problems of maladjustment should be part of training. Much can be done by a training department to assist in every phase of the method from the initial recognition of the problem, through the diagnosis and the devising of a remedial solution, to the setting up of both physical and psychological conditions conducive to a successful execution of the plan. It should be apparent, however, that some of this assistance must come from experts, that the method is not one to work successfully when placed in the hands of foremen or executives whose major interests are centered on other problems.[12]

It is obvious from the preceding description that attitudinal factors may have a significant effect upon the worker's performance, and that this effect may be looked for in any characteristic that is descriptive of the worker's proficiency. It should not be concluded from what has been written that to be out of adjustment is a sign of some mental abnormality. Readjustment of behavior to maintain equilibrium in a constantly changing complex world is very normal and natural. Training enters the picture as one procedure for assisting the worker to maintain equilibrium in his working environment. Many times the training must be directed toward a harmonious adjustment of the individual in phases of his living not directly associated with his job performance, just because job proficiency is complexly conditioned by these other phases. Training serves a vital role in assisting the worker to slough off those reaction mechanisms which are prolonging and intensifying his difficulties and to devise procedures which will get at the sources of his problems and effect a comprehensive solution.

THE PRINCIPLE OF INDIVIDUAL DIFFERENCES

Disregard of This Principle in Industry.—At first glance it would seem unnecessary to discuss and emphasize the importance of individual differences in industrial training. If there has been one finding in educational psychology substantiated beyond any reasonable doubt, it is the fact of individual differences; this means not solely that there are differences between individuals, but also that these differences persist to some extent despite efforts to erase them. The need for introducing the present discussion is due to the slow acceptance on the part of industry of the important role played by individual differences in industrial production.

Both management and labor have remained unconvinced of the stability of these differences. Management has emphasized production, has selected as the standard or goal the highest possible production, and this has led naturally to using the worker with the highest production record as the prototype for all others to follow. The procedure has been to find the type of job performance that gives the highest productivity and then through training to force every worker to perform according to this type. It has usually proved impossible to bring every worker to the performance established by the best worker. On the other hand, trends in the policy of labor organizations reveal a similar disregard for the operation of this principle. It is sufficient to point out that the trend in labor is not in the direction of establishing pay schedules on the basis of individual merit. Every worker with a given rating receives the same pay. It is common knowledge that there are wide individual differences in effectiveness of performance among workers of the same rating. The basis of reward for much labor nevertheless fails to recognize the principle of individual differences.

Basis of Individual Differences.—A further consideration of the meaning of the principle is in order. Individual differences are related to several well-established facts that the science of psychology has discovered. These will be stated rather briefly. All forms of behavior are conditioned by both hereditary and environmental determiners. The relative influence of the two cannot be stated for the case of behavior in general, but for some specific response it may be possible to learn whether hereditary factors are more or less important than experience factors. Factors from these two sources are reacting together in very complex ways, sometimes facilitating, sometimes inhibiting each other. In some specific behavior an overemphasis of environmental factors may compensate in part for the absence or presence in small amount of certain hereditary factors. Hereditary factors set limits to the functional development of structural determiners underlying behavior, and these limits are never exceeded by added emphasis upon experience factors. For every response for every individual, limits are set by natural hereditary factors, and it is these limits that are the basis of individual differences.

Implications of Individual Differences for Training.—From the foregoing facts two implications for training are obvious. First, through exposure, experience, and education it is usually possible to improve performance, and, second, there usually will be limits beyond which practice and training can realize no further improvement. Some of the difficulties encountered by the so-called "human engineer" come from his failure to recognize the importance of the second implication. Time-and-motion-study engineers have encountered individual differences in every study they have conducted, but they have failed to realize the stability of these differences and have forthwith attempted to erase them by their training programs. In recent times instead of using the one best worker, some engineers have utilized several better workers in establishing the times and motions to be used in training. The result has been an average considerably below the performance of the most effective worker. Further change toward recognition of individual differences is their admission that there may be several "best" methods of performing a response. Langley and Edwards found in their study that standard methods based upon certain good workers were not so quickly learned by some trainees as other different methods which proved to be equally rapid and productive.[13] The recognition by these authors of the stability of individual differences is not characteristic of most time-and-motion engineers.

Extent and Amount of Individual Differences.[14]—The extent of individual differences is greater than directors of industrial training are usually willing to admit. Differences are to be found in every form of response. Although the experimental studies have been preponderantly centered on abilities, aptitudes, skills, etc., differences between workers just as pronounced are to be found in drives, motives, interests, aversions, social behavior, personality traits, attitudes, opinions, and other similar modes of behavior.

In regard to the amount of individual differences the nature of the group being studied must be taken into consideration. Obviously, the more heterogeneous the sample of workers, the greater the probability of getting wider variations in performance. For present purposes the run-of-the-mill group of workers can be considered as possessing the differences with which training officers will be faced. When such groups are studied, and the amount of the differences between the individuals is measured by the range of performance, it is usually found that the best worker is some two to eight times better than the worst worker. These figures are representative of what has been found when the most reliable and accurate methods of measuring human response have been utilized. With differences of these magnitudes present in most performance situations, some thought should be given to the importance of such differences in industrial training situations.

Individual Differences in Learning.[15]—Variations in learning performance between different workers take several forms. First there are differences in initial performance. These differences may be attributable in part to differences in motivation, such as willingness to embark on a training program, differences in ability to understand what is wanted of them, and differences in ability to follow directions. Obviously there are more factors at work than simply the variations in the aptitude or ability to be trained. A second difference is in general rate of improvement. Some workers learn more slowly than others. It is not to be inferred from their slow improvement that they will never be as proficient on the job as their fellows who learn more rapidly. Neither is the opposite interpretation true—although frequently encountered—which holds that the slower learner gets a better grounding and therefore will eventually become more proficient than the worker who learns more rapidly. Neither of these generalizations can be made of all learning, but both of them receive substantiation in findings obtained from different kinds of specific learning situations. One fact does stand out, and that is, there are differences in learning rate between individuals in all types of learning situations. Rate of improvement, however, is not constant in an individual even with a given single task. As learning proceeds the individual may improve now rapidly, now slowly. This fluctuation in rate of improvement during the course of acquiring a new response again is found to differ greatly from one worker to another.

Another characteristic in which individual differences will be found is the ultimate level of proficiency attained at the completion of training or at any other later time after the worker has had some practice on the job. It is differences in this characteristic that training officers have labored diligently to erase. Experiments indicate that continued practice does not remove variations between learners.[16] It would appear from the many studies conducted in learning that there is an ultimate limit set by the physiological mechanisms involved in the reaction. This is true whether the response is one of coordination between muscular reactions, or one primarily mental in nature such as reasoning, remembering, etc. Furthermore physiological limits exist for various characteristics of behavior such as the rate of movement, the preciseness or fineness of the coordination, and the ultimate level of difficulty at which acceptable performance is achieved. As has previously been indicated, these physiological limits are set by hereditary factors, and little if anything can be done through training to extend them.

The relationships between the three variables--initial performance, rate of learning, and final level of proficiency—will quite naturally vary considerably with different tasks. An example of the relationships that are found is furnished by an investigation of Blankenship and Taylor, who studied the performance of power-sewing-machine operators on three different jobs for the first 50 weeks of work.[17] Initial performance was measured by success during the first 10 weeks, speed of learning was measured in terms of the time required to meet a standard of proficiency, and ultimate proficiency by production for the entire period. The results, given in Table 83, show rather marked differences among the jobs but in general indicate that ultimate proficiency is better predicted by speed of learning than by initial performance. Initial performance, however, gives a fair prediction of speed of learning.

TABLE 83.—THE RELATIONSHIPS BETWEEN INITIAL PERFORMANCE, SPEED OF LEARNING, AND ULTIMATE PROFICIENCY IN LEARNING ON THREE POWER-SEWING-MACHINE JOBS

Correlation between	Type of job		
	Trimming	Covering	Hemming
Initial performance and ultimate proficiency	0.68	0.01	0.66
Speed of learning and ultimate proficiency	0.74	0.52	0.59
Initial performance and speed of learning	0.66	0.41	0.32

Differences Due to Method.—So far the individual differences considered have been referred primarily to the worker's aptitudes, abilities, traits, etc. Other factors, however, come into play during learning to determine in part the differences found in performance. Some of these factors are related to methodology in teaching and learning and will be discussed later. It is sufficient here to recall the common occurrence in industrial training of variations in the learning rate of new employees under different foremen-trainers. The approach and method of some foremen get much faster results from the learners than those characteristic of other foremen, indicating that differences in method of teaching will produce differences in performance of the trainees.

Adjusting Training to Individual Needs.—The presence of individual differences in the characteristics described in the preceding paragraphs makes it necessary for training officers to adjust training programs to individual needs. When the responses to be taught are simple in nature and the trainees have been selected carefully, individual differences present little difficulty to the trainer. The more highly complex the responses to be developed, as well as the less carefully the trainees are selected, the more important are the problems arising out of individual differences. In the light of present knowledge it is probably safe to conclude that with higher mental processes and with complex psychomotor coordinations there is no procedure that can be followed by the training officer that will enable him to ignore individual differences and still achieve the greatest returns from his training program.

What training can do is to assist the individual worker to develop his aptitudes to the highest degree, so that he is working at a level of performance at which he is utilizing most of his potential ability. This assumes that the final level of performance will be established comfortably within the psychophysiological tolerances of the worker. What training programs cannot do is to remove or eliminate individual differences among workers, and therefore management cannot continue to cling to the unsound notion that every worker, or even the majority of workers, can be taught to perform at the level of the best worker.

MOTIVATING FACTORS IN LEARNING

The motives for learning are very largely the same motives actuating the worker on the job. He desires to learn because he is in need of a job, or he wants to qualify for a higher position, or he expects increased financial returns, or he anticipates greater prestige, or because of other results that he thinks will further his personal status. The reader will recognize that these are motives common to many nontraining situations. In the discussion to follow, no attempt is made to list systematically all motives important for learning, but, rather, general suggestions are given to point up the nature of some of the problems of motivation involved in training.

Personalized Motivation.—In agreement with the general point of view of individualized training already advanced, one of the primary requirements is that there be personalized motivation. The first step in obtaining this is to create in the worker a desire to undertake the training. This can be done by explaining in detail the conditions that gave rise to the need for a training program, making available all the facts and advancing and explaining the reasoning involved in justifying the program. It should be made plain to him why he should effect a change in his job performance, how this change will contribute to his personal adjustment, and what individual returns he can anticipate from the change. Also, he should know his contribution in terms of the larger picture of his department, of his division, and, lastly, of the firm. Next, the worker should be made thoroughly acquainted with the demands that the training will make on him—what he must contribute in time and effort to complete the training. He should know these requirements at the beginning of training before he identifies himself with the program.

Until the worker has become convinced of the need of the training, of the worth-whileness of the returns he will receive, and of the sacrifice it will entail, learning, for the most part, will be slow and primarily incidental. The level of motivation will be extremely low, and the results of the program will not be worth the time and cost it will entail.

In creating a personalized motivation each worker must have goals toward which the training will advance him, and in the absence of such goals the first function of training is to assist the worker to establish them. So much of training and education revolves around the development of skills that training in motivation, in goal setting, in foresight and planning, is lost sight of. Training departments cannot avoid influencing the formation of goals in its trainees, but usually such influence is incidental and unplanned. What is needed is planned instruction that will assist the worker in identifying himself with goals that will result in further advancement in remuneration, satisfaction, and security. Goal-directed behavior is far more productive than undirected behavior. High incentives greatly speed up learning and result in higher retention values.

Use of Incentives in Training.[18]—In addition to the motives referred to above, there are other factors which influence the worker's interest and performance in training programs. Greater achievement results when certain concessions are given the trainee for what appears to him to be extra work, *e.g.*, such concessions as having all training conducted during working hours and not utilizing the evenings or nonworking hours of the trainee. For new employees a necessary incentive is a satisfactory rate of pay during training, which has an added influence if the pay is graduated in terms of achievement in learning. He will then be motivated to learn faster because the financial returns will be increased according to his progress.

Another step that may be taken to facilitate learning is to keep the trainee fully informed of his progress.[19] Even though the response to be mastered is some form of motor skill, in which he can readily observe his improvement, he is still in need of the verbal pat on the back by the training officer.[20] Trainees usually are not competent to judge the goodness of their performance and they profit greatly from the evaluation of their work given by supervisors and instructors.

Whenever possible the performance should be described quantitatively—given some kind of numerical rating or score. In the trainee's thinking such a score is concrete, *i.e.*, has much more definite and real meaning than a qualitative description. A further value of such a score is the greater self-competition that it engenders. The trainee gets a better conception of his progress and strives to better his performance with each additional day of practice. When several individuals are in training, social rivalry and competition can be utilized to keep up the tempo of learning. Experiments indicate that there is a mutual stimulating influence between workers that heightens the motivation to learn.[21]

Finally it is important that management provide rewards commensurate with the amount of training accomplished. This does not necessarily mean increased pay. In time of technical improvements when certain jobs are abolished, the displaced worker's reward for training may be continued employment through transfer to another job. This, in itself, is ample enough reward when the alternative is unemployment. Increased responsibility is another objective which workers seek as reward. Rosy promises of rapid advancement which management cannot fulfill and never intends to fulfill, function only once, and from then on all subsequent training programs are deleteriously affected. The worker must have the assurance that the training will result in an improvement of his personal adjustment, and that it is not solely organized to increase profits. There are very few if any training programs that cannot be interpreted in terms of the workers' advancement.

ASSIMILATION THROUGH COMPREHENSION AND INSIGHT

Assimilating the New through the Old.—In the individualized approach being advocated for industrial training it is important to adjust the tasks to be learned to the ability of the trainee. With the goal established of each worker performing up to his psychophysiological tolerance, and with knowledge of the wide range of differences characteristic of groups of workers, it is necessary to vary the training to fit the learner. It is common knowledge that the new can be understood only by means of the old. The comprehension and assimilation of new things, whether these are subject matter, facts in the form of information, or the development and improvement of skills, can be achieved only through the knowledge and skill the worker has already developed. To some degree the rapidity with which the assimilation will occur is dependent upon how closely the individual's past experience is related to the new, and to the extent to which the experience can be brought to focus on that which is to be learned.

The application of the old upon the new cannot be left to chance or to hit-or-miss exposure incidentally provided. A conscious and directed attempt should be made to adapt the material to the ability and experience level of the trainee's background. This does not mean in a general way but in a rather specific individual way for each worker. The nature and extent of the relations of the old with the new will vary greatly for different individuals, and so the old must be tied to something familiar to each individual learner. This principle of assimilation has received ample confirmation in many educational experiments, and there is little doubt concerning its important role in industrial training.

Logical versus Rote Learning.—A question arises concerning the best method to use in effecting a strong relationship between the old and the new. There is no doubt but that a procedure which stimulates comprehension and understanding on the part of the learner is superior to one which primarily advocates a mere repetition of the task.[22] This is the old argument between rote learning and logical or insightful learning. In rote learning the task is repeated in a drill fashion, as is done so frequently in the learning of the multiplication tables in grade school. In logical learning an attempt is made to introduce as many meanings into the new experience as is possible.

and through these meanings to assimilate the new into the body of past experience.

Cox made a study of teaching methods in training workers to assemble electric lamp holders.[23] He compared mechanical repetition of the task with instructed training in which general principles and meanings underlying the operations were explained and practice given on certain important aspects of the assembling. The performance of two groups of individuals, with equal initial ability but exposed to the two different methods, was compared. The group using the logical learning method showed significantly greater gains in proficiency than the group using the rote method.

Arousal of Meanings during Learning.—In logical learning the meanings that are aroused can involve any and all aspects of the task to be learned. Primarily they should include the nature of the task; if it is a new way of performing a motor response, then the exact way of performing the response should be understood; if it is some verbal material to be mastered, then the exact nature of the concepts involved should be made known. Other meanings that should be utilized are the relationships that the new task bears to other similar tasks, the applications that can be made of the new task, and the way in which the new task will contribute to the worker's future development. In general any meaning that the new task may have for the trainee will assist in increasing his comprehension of it, and it is through this comprehension that the task will be learned and remembered.

One objective toward which the new meanings should be directed is the establishment of general principles of attack that will encourage the trainee to modify his behavior when difficulties are encountered. A common finding in studies of learning is the persistence that the trainee shows in repeating responses that have proved inadequate. This is particularly true in problems having no ready solution. The learner should be taught to vary his attack and not perseverate in repeating an inadequate response. Through instruction in logical learning this can be done, and the reduction in perseveration that follows greatly facilitates the learning. This is illustrated in a study by Maier in which the instructions on general methods of attacking a problem were varied with two groups.[24] Before beginning work one group was merely told what the problem was and given the equipment required to solve it. The other group received a short lecture on general methods of attacking problems. The lecture was not directed specifically to the problem at hand but was directed to the need of avoiding perseveration of inadequate reactions. A significantly greater proportion of the second group solved the problem within the time limit set.

Effect of Comprehension on Motivation.—Comprehension of the new will make the learning more rapid and the retention more stable, but the effect does not end here—there will be a direct facilitating effect upon the motivation of the learner. Everyone has had the experience of wanting to give up the learning of a task because it proved too difficult to do or to understand. Wanting to quit or wanting to go on is a matter of motivation. It requires a higher level of motivation to learn in the face of difficulties or lack of understanding. With comprehension and insight there follows more interest and desire to learn with the result that the learning becomes easier.

THE FUNCTION OF PRACTICE

The Meaning of Practice.—Although, as pointed out above, the method of logical learning is superior to mere repetition of the task, the perfecting of any new form of behavior to a high level of proficiency requires practice. Practice refers to the repetition of the task in an effort to improve performance.[25] Understanding of a new form of behavior is seldom sufficient in itself to enable the worker to perform the behavior; practice usually is necessary. A response may be considered learned when there has been very little practice, *i.e.*, if it can be performed according to some criterion. In most instances, however, the criterion is far from a perfect performance. For example, a person may say that he has learned to play tennis after playing only a few games. He does not mean he is an expert, but rather that he has learned the game at a rather low level of proficiency. Through practice he expects to continue learning, and he may improve sufficiently to be eventually considered an expert. Blind practice, *i.e.*, practice during which the learner does not react mentally to the task, occurs infrequently during learning. Usually the practice involves some attention and conscious direction.

Practice is not to be associated solely with learning by the novice or the new employee. Many experiments have demonstrated that so-called "experienced" workers can effect improvement through systematic practice. Seashore cites an experiment in retraining experienced open-hearth furnace crews in which the total improvement amounted to 9.4 per cent.[26] During the fourth period of retraining nearly 3,000 additional tons of steel were produced per week as compared with the average production previous to retraining. As with new learners, improvement of experienced employees may be manifested in speed of performance, accuracy of performance, ease of performance, or change in the method or form of executing the task.

Habituation.—One of the functions of practice is to develop the task to the point at which it can be performed automatically or habitually.[27] In the beginning of learning, the performance of a task requires conscious direction on the part of the learner. Whether the task consists primarily of mental reactions or motor reactions, it requires that he direct his attention upon the different phases of the behavior. For example, in the operation of a lathe the worker has to respond with both hands at varying speeds of movement and in various positions in space. There are also finger movements of varying complexity. All these reactions are dependent upon spatial judgments, which in turn are dependent upon visual acuity and sensitivity. To operate the lathe successfully the beginner must attend closely to many details. His performance is slow and his movements somewhat awkward and uncoordinated. As the task is practiced, the simpler aspects demand less of his attention and eventually run their course without conscious direction. Further practice brings more complex aspects to an automatic level, until a large portion of the sequence of response may require no attention from the performer. This habituation frees conscious direction so it can be focused upon the more difficult phases, such as the proper timing of the movements.[28]

Reduction of Effort and Work Decrement.—Coincident with the reduction of the conscious direction there is a reduction in the effort required to perform the task. There is considerable mental effort involved in concentrating and attending. Especially is this true in the beginning of learning when so many aspects are competing for attention that the learner cannot afford to relax at all but must shift from one aspect to another at a high level of vigilance. As each aspect is reduced to a habitual level less effort is required to perform it. This means that more work can be accomplished before feelings of tiredness set in, as they will from continued direction of the attention over a long period of time.

The decrement in work will also be lessened through a reduction in muscular tension incident to performing the task. This is particularly true in psychomotor responses, where large motor components are involved. In the initial stages of learning the worker is tense, knitting his brows, gritting his teeth, squinting his eyes, or in other ways expending energy not directly part of the task. This superfluous reactivity is utilized as a support to the main task when it is strange and unfamiliar to the trainee. Part of this excess tension seems to serve a legitimate function as postural background against which the more precise movements of the task are developed but whose usefulness is lost when these movements become automatic. Part of this tension arises from awkwardness and incoordination of muscle groups which are essential to the task but over which control has yet to be brought to a high level of precision. As practice proceeds this excess tension gradually declines, and in a highly perfected reaction it may be markedly reduced.[29]

Improvement in Speed and Accuracy.[30]—Improvement in speed and accuracy of response probably is the most familiar change produced from practice. It was in connection with the quantitative measurement of these variables that learning curves were developed. These curves graphically represent the changes in performance that follow from continued practice. The amount of practice, measured in time or trials, is represented on the horizontal axis, and the efficiency of performance, measured in terms of units of work done or the number of errors made, is represented on the vertical axis. The proficiency achieved is plotted for each period of practice, and these points are connected to make a curve. Improvement is shown graphically by the rate of change in the curve. Figure 31 is a learning curve for new workers in a printing plant.[31]

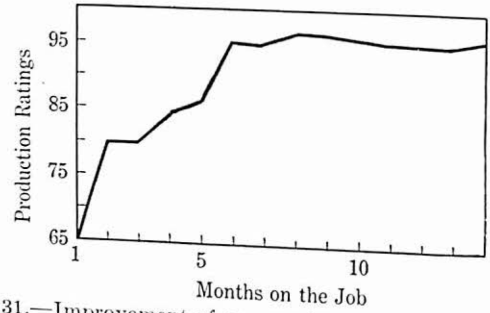

FIG. 31.—Improvement of new workers in a printing plant.

It is apparent that, if the same increment of improvement is achieved for each practice period, *i.e.*, if the rate of improvement is constant or uniform, the curve will be a straight line, the steepness of which will depend upon the amount or rate of change effected. Nearly all curves of practice are negatively accelerated. This means that the improvement occasioned by each succeeding practice period gets less and less. The largest increments of change occur early in the learning and gradually approach zero as practice is continued.

The initial level or base from which improvement begins is dependent upon the individual's past experience in similar tasks and upon his understanding and comprehension of what is required. Seldom if ever is the initial level found at zero proficiency. The final level is variable and depends upon a great many factors. Most of these may be subsumed under the two following categories: physiological limitations and motivational conditions. Physiological limitations differ for different individuals. For most responses the worker seldom performs at his physiological limits.[32] To keep up efficacy of response at these limits requires an expenditure of energy that most workers will not tolerate. The final level of proficiency is more frequently determined by motivational factors. It is usually that level with which the worker is content, that level at which he gives up striving for further improvement. Obviously, individual workers will vary greatly in these factors, so that the levels of their final proficiency will differ widely at the end of any formal practice period.

Changes in the Form of Response.—Practice may not only increase the efficiency of responses in use at the beginning of learning but may in addition result in changes in the form of the responses or the way in which the final product is achieved. Complex performances involve the coordination of several part reactions. Some of the organization into complex performance takes place in time so that temporal linkages between individual reactions are effected. This may be illustrated in a simple situation where the task set for the individual is to tap six keys in the order 1, 2, 3, 4, 3, 5, 6, 1, and where the time necessary to make the movement between each pair of keys is measured. In Table 84 the time for each movement is expressed as a percentage of the total

TABLE 84.—RELATIVE SPEED OF MOVEMENT AT THE BEGINNING AND END OF LEARNING IN A KEY-TAPPING TASK

Movement between keys	Relative time to make the movement		
	Early trials, per cent	Late trials, per cent	$\frac{\text{Late trials}}{\text{Early trials}}$ $(L \div E)$
1 & 2	13.9	16.6	119
2 & 3	12.2	11.6	95
3 & 4	15.0	16.2	108
4 & 3	14.3	13.1	92
3 & 5	11.8	12.4	105
5 & 6	16.4	16.0	96
6 & 1	16.4	14.1	86
Total	100.0	100.0	

time to complete the sequence. Although at the end of learning the total time to complete the sequence dropped some 20 per cent, it will be noted that some of the movements require relatively more time in later trials than in earlier ones, and for others the relative amount of time is decreased. Thus in terms of the pattern of the speed of the component movements the final perfected act may not be the same as the act during the initial phases of learning the performance.

During learning, reactions in different muscle groups are integrated and coordinated as parts of a larger unitary response. In the beginning of learning, as previously pointed out, these individual reactions may be crude and awkward. Fineness and precision of movement come from practice. New linkages are found, and old linkages dropped out. Short cuts are discovered and built into the reaction. Smoothness of coordination is gradually acquired.

With complex reactions, improvement may sometimes be a direct function of the method of reacting. The worker may approach what seems to be the maximum performance for a given method of reacting, at which time improvement stops, but then he finds that by changing the method he again improves his performance with further practice. This brief time of no improvement is called a "plateau." It is found in complex psychomotor tasks like typewriting and telegraphy.[33] In such a task as typewriting, after the trainee has learned to type letters and has continued his practice for some time, the point is reached where he does not show further improvement. Then when he learns to think of a whole word as a unit, instead of using each letter of a word as a unit, and learns to manipulate the keys in terms of word units instead of in terms of letter units, further practice again brings improvement.

From the foregoing discussion it should be apparent that practice plays a very important role in the perfecting of any performance. This is especially true when there is a large motor component, although there are mental skills, such as arithmetic manipulation, facility in use of the alphabet in filing, manipulation of numbers in stock recording, recognition and recall of names, etc., where practice is necessary if a high level of achievement is to be attained. Through practice certain phases of the response are automatized, superfluous reactions are dropped out, excess tension is eliminated, precision of movement and smoothness of coordination are effected, and the energy requirements of the total performance are greatly reduced, so that a high level of efficacy is attained within the psychophysiological tolerance of the individual.

Practice in Formal Training.—The question arises as to how much practice should be given in a formal training program and how much should be relegated to on-the-job performance. No single answer can be given; it must be worked out in terms of the specific conditions operating at the time of training. Several general statements can be made which should be considered in arriving at the answer. First, enough instruction and practice under supervision should be given to ensure that correct responses will be formed. Secondly, the more complex the reaction, the more formal supervision of practice will be required. Third, follow-up procedures should be formulated and executed so that practice on the job will achieve the high order of proficiency desired. The latter step is of considerable importance. The desire of management to get the worker into a productive job and the desire of the worker to start working under real job conditions are conducive to a shortening of the formal training period. Knowing this, management should make sure that a careful and adequate follow-up of the trainee is made after he is placed on the job.

TRANSFER OF TRAINING

The problem of transfer is concerned with the degree to which the learning of one subject or skill influences the learning or performance of other subjects or skills. To what extent will the knowledge, attitudes, insights, procedures of response, etc., learned in one situation affect performance in some other situation? This problem is of practical importance for industry, having implications not only for training programs for new employees but also for the adjustments of older workers transferred to new jobs. There have been a large number of investigations conducted by psychologists on transfer effects. Some of the findings of these experiments have direct bearing on the problems encountered in industrial training.

Nature of Transfer.—The transfer effect may be either positive or negative; *i.e.*, the learning of one act may either facilitate or hamper the subsequent learning or execution of another act. One form of negative transfer frequently encountered is called "habit interference." This is illustrated by the difficulties one encounters in learning to typewrite with the touch system after having typed for several years with the "hunt and peck" system. Several explanations have been offered to account for transfer,[34] the two most widely accepted involving the carry-over effects of general principles, and identical or similar components.[35] In the first the general principles are thought of as abstractions about which generalizations to more than one situation can be made. For example, a principle of attack learned in one situation may require that the learner always study the problem as a whole before analyzing it into its parts and attacking each part separately. Such a general principle when applied to new problems may facilitate or retard their solutions. If applicable in the new situation there should be a positive transfer effect. If the principle is inapplicable, whether or not it is so recognized by the learner, the effect probably would be negative or detrimental in character.

According to the theory of identical components the new situation and the familiar situation have parts in common. "Parts," as used here, may refer to response components, stimulus characteristics, attitudinal elements, techniques, etc. Sometimes even similarity of principles is included, and no distinction is then made between the two theories. As an example of identical components, a positive transfer should be expected between learning arithmetic operations and bookkeeping because of similarity of components.

Transfer from Training to Job.—In setting up a training program it is important to give some concern to the relationship between the learning situation and the job situation. One general suggestion frequently made is that the trainee should do his learning under conditions identical with those with which he will be faced on the job. This generalization needs further examination. The specific purposes of training are not identical with those of job performance. In addition to being concerned with production, training is concerned with instilling correct understanding, correct modes of response, correct attitudes, and correct motivation. There may be certain conditions characteristic of the job that would have a detrimental effect upon one or more of these other objectives.

For example, suppose the performance is one of operating a punch press, and on the job the task must be executed in a noisy, distracting environment produced by the operation of many other machines. Teaching correct procedure would be detrimentally affected under these distracting conditions; therefore training should be conducted in quiet surroundings. Then, after correct procedures have been established, practice should be given under the noisy conditions. A distinction, then, must be made between job factors that facilitate training and job factors that retard training. The argument is not being advanced that training under exact job conditions would not show a high degree of positive transfer, but rather that the greatest positive transfer effect would result from an intelligent discrimination of the effects of job factors upon training, and the use of these factors at different stages of the learning.

The learning of *correct* methods of work during formal training is important owing to the possibility of negative transfer. One of the common findings in industrial training is the ease with which incorrect work methods may be acquired by the new worker. Once learned, there may be considerable difficulty encountered in breaking up these methods and replacing them with correct methods. Through negative transfer, wrong methods of work may unduly prolong the initial adjustment problems of the new worker when he is placed on the job. A good example of negative transfer is the classical study of bricklayers by Gilbreth.[36] The method of work learned in formal training had to be unlearned because it differed so greatly from the way the tasks actually were performed on the job.

Transfer from training period to actual performance on the job must be conceived as taking place in all aspects of a given job task. There may be either positive or negative transfer effects in methods, procedures, and techniques of work, in the speed of responding, in the accuracy of the performance, in the interest, drive, and urge to respond, in the attitude toward all phases of the work, and in any other characteristic attributable to the job performance. An example of negative transfer effect from the speed of performing the reactions is that of Gilbreth on bricklayers already cited. He found that trainees instructed under slowed-down conditions learned a set of movements that handicapped them in performing under the normal working speed. It was necessary for them to learn a different set of reactions under the faster rate used in actual bricklaying. It also was found that these earlier reactions retarded the speed of learning of the correct responses.

It must not be thought that these transfer effects are found only between training and job performance of novices; they apply equally forcibly to the training of older workers for new jobs. The problem with older workers is of even greater difficulty because of the potential transfer value from their old skills and abilities to their new type of work. Skills similar in nature to the new may not necessarily show positive transfer to the learning of the new task.[37] Negative transfer effect may result when the more rapid pace characteristic of the older skill is applied to the new with resultant mistakes and breakdowns. The worker finds it difficult to slow his pace to a rate commensurate with his unfamiliarity with the new tasks. Even when no formal training is given to the old worker before he is transferred to a new job, there must be a transition or breaking-in period during which any interference from his old skills can be overcome and adequate adjustment made.

EFFECT OF EMOTIONAL FACTORS

It is unlikely that a response is ever performed in the total absence of any feeling or emotion. Motor and mental reactions involved in worker performance are closely integrated with the likes and dislikes, satisfactions and annoyances, appetites and aversions, and other similar reactions of an affective and emotional kind. Learning, like all other forms of behavior, is influenced by the kind and intensity of the emotional reactions associated with it. Occasionally the emotion present will be sufficient to stamp in the learning in one trial or repetition, as when a fear is established for a lifetime after only one exposure.[38] The emotion may facilitate learning, as when the offer of generous rewards, predicated upon completion of training, intensifies the interest and drive in the learning. Again it may prove detrimental to learning, as when anxiety aroused from fear of failing a course of training may reach such an intensity as to inhibit learning.

Source of Emotional Disturbances.—Emotional reactions aroused during training may stem from many different sources. Of course factors arising from the job situation usually are predominant. Job skill, job satisfaction, job advancement, job security, etc., contain many emotion-provoking problems. Anticipation of, or actual maladjustment in any of these regions will give rise to emotional responses that will affect the learning rate. Maladjustment in social, family, recreational, religious, and other nonworking environments will likewise give rise to worry and anxieties that will affect training and job performance.

Nature of Emotional Effect on Learning.—As indicated, emotion may either facilitate or retard learning. When the emotion arises from positive motivational factors it usually facilitates learning.[39] There is then a higher level drive, more intense interest, anticipation of reward from achievement, and other similar experiences that spur the trainee to greater effort and application. A negative effect may result when the worker anticipates failure, thinks he is gradually losing out, or feels the effort involved in the training is not justified by the anticipated returns. Then the feeling may tend toward depression and slow down the rate of work. In general, mild excitement tends to improve learning, whereas mild depression tends to retard it. One of the explanations of the facilitation of learning under conditions of competition, such as is found in group rivalry, is in terms of the excitement the contest engenders.

Usually intense emotion, whether exciting or depressing, interferes with learning. The effect may be transitory, which is often the case when the emotion itself is of short duration. When the emotion persists, then considerable interference and retardation take place, and the effect may be of long duration. McKinney studied the effects of rather intense emotional stress on the learning of a stylus maze.[40] In one experiment a group of subjects was made to feel inferior by being told that they should complete the task in 6 min., which was a rather short interval for the task. The end of the interval was indicated to them by a sound. If it were necessary, they were to go on and complete their learning after the interval. A buzzer was sounded every minute, which provoked considerable emotional expression. The group averaged 136 errors in learning, whereas a control group, who were merely told to learn the maze, averaged only 53 errors. Other experimenters have noted similar interference with learning and retention from emotion provoked by various forms of stimulation.[41]

Interference of Emotions upon Job Training.—Emotion interferes with learning in several ways. Inattention and daydreaming occur. The learner gets engrossed in his effort to solve problems other than those at his workbench, and his mind wanders away from the task at hand. He is more easily distracted. He is jittery and excitable, and minor distracting stimuli to which he formerly paid no attention are now sufficiently powerful to interfere with his concentrating on the job to be learned. Worry and anxiety, which are emotional responses of long duration, inject themselves at all stages, with the result that conscious direction of the learning is upset. As a culmination of these various factors the worker's responses are slowed up, and much incoordination and disintegration ensues. The interference then is transmitted into various forms of ineffectiveness such as decreased rate of learning, decreased precision in response, increased accidents, increased susceptibility to boredom, earlier onset of work decrement, and other similar detrimental effects.

To minimize detrimental emotional conditions the trainee must be adjusted. To maximize the effect of facilitative emotions the trainee must be highly motivated to learn. Both of these topics have received consideration earlier. It should be sufficient here to point out that it will pay dividends to management if it incorporates in the training programs facilities for solving problems of adjustment and motivation. These problems are inseparable from the problems of learning. When there must be a transition or breaking-in period during which any interference from his old skills can be overcome and adequate adjustment made.

EFFECT OF EMOTIONAL FACTORS

It is unlikely that a response is ever performed in the total absence of any feeling or emotion. Motor and mental reactions involved in worker performance are closely integrated with the likes and dislikes, satisfactions and annoyances, appetites and aversions, and other similar reactions of an affective and emotional kind. Learning, like all other forms of behavior, is influenced by the kind and intensity of the emotional reactions associated with it. Occasionally the emotion present will be sufficient to stamp in the learning in one trial or repetition, as when a fear is established for a lifetime after only one exposure.[38] The emotion may facilitate learning, as when the offer of generous rewards, predicated upon completion of training, intensifies the interest and drive in the learning. Again it may prove detrimental to learning, as when anxiety aroused from fear of failing a course of training may reach such an intensity as to inhibit learning.

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FACTS ABOUT TEACHING IN INDUSTRIAL TRAINING

The Older Method.—One of the earliest methods of industrial training, and one still in frequent use, places a new worker beside an old-established worker who is charged with the instruction of the newcomer. This method has more disadvantages than advantages when evaluated in terms of principles of pedagogy, but it has continued to persist because of management's failure to recognize the importance of expert teaching in its intense drive toward getting the trainee into productive work. If the older worker selected as a teacher continues his emphasis on high output, which often is the reason for his being selected to do the teaching; if he is temperamentally unsuited for teaching, which the majority of workers are; and if he feels resentful and frustrated because there is no particular incentive offered him for the extra preparation and time teaching entails, which frequently is the case; then he will consider teaching an extra chore, the new worker will be neglected, and the training program will fail.

Importance of Trained Teachers.—That learning is aided by teaching needs no argument. The establishment of educational systems with their compulsory attendance attests to the importance of subjecting the trainee to guidance during the time he is learning. There may be some need, however, for emphasizing the importance and advantages of expert, or at least trained, teachers over the ordinary worker assigned the task of teaching.[42] There has been too widespread acceptance of the following dictum suggested by the Gilbreths and called the *three-position plan*, in which every employee is responsible for one job, learns another, and teaches another.[43] This plan rests on the basis that anyone can teach, a point that can be argued negatively with telling effect. Rather than press the issue further, however, the assumption will be made that better instruction can be obtained from expertly trained teachers than from untrained workers, an assumption that will meet little challenge. Suggestions should be made supporting the thesis of getting well-qualified teachers, rather than depending upon the older method of utilizing high-producing workers or any worker who happens to know the job for which training is needed.

Some Tasks of the Teacher.—In previous topics the method of individualized training has been advocated. To be successful this method requires that the teacher be able to detect the difficulties encountered by each trainee and to adapt the instruction to meet his specific needs. It requires thorough knowledge of the job performance to learn the faults of the trainee, and the pedagogical insight of a good teacher to assist him in replacing the faulty reactions with correct ones. Planned instruction has as its object the preparation of the trainee in the shortest possible time. This can be realized only when trial-and-error learning—the floundering around characteristic of unsupervised learning—is held to a minimum. A well-trained teacher knows which errors can be avoided completely and which errors are needed to achieve comprehensive learning, and thus he can minimize the loss occurring from blind hit-or-miss responses.

Logical learning through comprehension and insight has been advocated as being superior to other methods. Understanding can be promoted best by explanation during the learning process. The worker needs to know not only the "how," but the "why." He should be instructed in the reasons why a reaction is made in one way and not another, why one procedure is superior to another. Expert teachers, who know not only how to perform a job but also the whys and wherefores, are needed to give the explanatory instruction basic to understanding and insight. Trainees progress faster when their attention is focused on the important aspects of the learning, and they are prevented from wasting effort on the routine and easily learned aspects. In other words there must be a directed and insightful attack on the learning problems if the maximum rate of improvement is to be realized. It can hardly be maintained that any worker with a little extra training will be capable of making correct differentiations and of exercising the foresight that such direction of the trainee requires.

Lastly, one of the most important abilities of the teacher, and often the one that differentiates a good teacher from a routine instructor, is his capacity to stimulate the trainee to work at a high level of performance. Teachers must inspire through their teaching. They must make the learner feel a personal need for the training. They must keep his interest from flagging when the going gets tough. They must stir up the listless worker and fire him with ambition. These things are not easily accomplished but are essential to obtain maximum motivation in the trainee and thus the fastest rate of learning. Such achievements are not to be expected from any or every worker who has been drafted to teach but should be expected in varying positive amounts in workers who are selected because they have the qualifications for teaching, and who have received training in how to instruct.

Qualifications of a Teacher.—A few of the qualifications of a good teacher should be mentioned. The two principal characteristics are, first, the ability to teach and, second, a sincere desire to teach. Neither of these qualifications is easily analyzed or measured. Ability to teach includes the following: ability to understand and perform the tasks to be taught, ability to detect and understand the problems the trainee will encounter, ability to explain the methods and procedures clearly, and ability to correct the trainee kindly and sincerely. Desire to teach includes interest in aiding to advance others, liking for instructing others, patience in eliminating the faults and errors of the learner, and satisfaction from seeing the trainee grow and develop in the job. To be successful as a teacher the worker should have a temperament that makes him socially responsive, interested in people, and helpful to them.

The teacher does not necessarily have to be a high producer or the fastest worker, but he should not be selected from among the inferior workers. He should, however, represent in his performance the desirable qualities to be taught to the trainee. For example, if the work demands speed above accuracy, he should not be a meticulous worker whose production is retarded by his overemphasis upon accuracy. If the product must be perfect and speed is subordinated to accuracy, then he should not be the "speed demon" who has a high production but whose wastage is uneconomical.

The worker selected to instruct should be amenable to teaching. He must be taught correct methods of work and sound pedagogical devices for teaching. He must be open-minded with respect to these factors in order to be willing to accept the standard procedures and objectives that comprise the training program, which may be at variance with his own ideas and practice. If there are to be several instructors, standard methods and procedures will not be taught the trainees if each instructor is allowed to train according to his own interpretation of these standards. Viteles demonstrated many years ago, in his experiment on streetcar motormen, the interferences, retardation, and waste ensuing from the use of variable instruction methods.[44]

It should be apparent that the composite of qualifications outlined above is not held by a large proportion of the working population. There also is no assurance that this composite is to be found most frequently in the highest producers. Two qualifications characterizing the highest producers are ability to perform the task and a strong drive to excel. The first is necessary for teaching, the second is likely to interfere with teaching. The solution is to select teachers from among the good workers with concern for teaching qualities other than ability to do the job.

Incentives for Teaching.—A phase of teaching in industrial training due for more consideration by management in the future is the phase of teacher motivation. The question should be asked: What steps can be taken to make the task of teaching attractive and to motivate the teachers to perform at high levels of effectiveness? To glance back at the past one finds teaching considered an added responsibility, a side issue, an extra. On the whole, management has failed to realize that superior teaching is good business, just as superior materials, superior workmanship, superior products, etc., are good business.

Teaching in industrial training is deserving of far greater recognition and attention from management than it has been receiving. Teaching carries added responsibility, requires thought and planning in its own right, and is of a higher level than mere performance of the work, or job, to be taught. It therefore should carry higher remuneration. Because of the work entailed, the instructor should be freed of some or all of his other functions, depending upon the teaching load he carries. No set load can be suggested; it must be determined in terms of the factors present in the specific training programs. One generalization can be made; *i.e.*, the time involved in teaching encompasses more than the period of actual instruction, and allowances must be made for the preparation, planning, and evaluation, which, together with actual instruction, comprise the teacher's job.

It should not be concluded that added pay, or allocation of time for doing the job, are the sole incentives that can be offered the potential worker-teacher. Greater recognition by management of the importance of the job would increase the prestige of the teacher. Soliciting the assistance of the potential worker-teacher in the formulation and organization of the training program goes far toward increasing the motivation. If he participates in the planning, he identifies himself with the program, or, better, he considers the program his own. He then feels a personal responsibility to see that it succeeds. This is one of the soundest ways to establish high motivation in the teaching corps.

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CHAPTER XIII

PRINCIPLES AND METHODS OF INDUSTRIAL TRAINING

The rapid development of mass-production methods and the continued improvement of technical processes have been accompanied by increased worker proficiency and a growing independence of the employee through his labor organizations. The problems of worker adjustment arising from these changes have been many, and in looking into the future there are no signs of abatement. Their solution, if it is to be achieved through the methods of individual initiative and enterprise, should not be subjected to greater and more restrictive governmental regulations. It must come by way of the educative process through which greater mutual trust and cooperation can be established between employer and employee. Industrial training is part of this educative process and must play a vital role in the solution of future industrial problems. This can come about, however, only if management has the foresight and vision to establish a progressive training policy, one that will encompass those aspects of human behavior from which mutual trust will develop. Such a training policy will not be inimical to the established objectives of industrial training programs.

SCOPE OF INDUSTRIAL TRAINING

The tendency to think of training as merely comprising training departments, teachers, classrooms, projects, manuals, and trainees is an extremely limited conception. Industrial training should be conceived as being as narrow and specific as an individual worker's problem and as broad and general as any phase of the industry. As pointed out in the preceding chapter, it should be individualized and involve the adjustment of every worker; it should encompass every phase of the worker's living that may affect his adjustment on the job. It should be primarily established on the concept of the "worker's adjustment to his work." This point of view does not oppose or undermine the training prevalent in industry today but merely broadens the base on which this training can be conducted. Production as the ultimate objective is still championed, but it is supported against a background of individual achievements, goals, and satisfactions. Once so supported, the ideal of maximum production consistent with the worker's psychophysiological tolerance should be not only easily attained but also should be readily maintained.

Employee training should begin from the moment the worker is hired. Even before any attempt is made to train him in job responses, instruction should be given in orienting the worker to the job, the department, the plant, and the industry. Facts that will show the importance of the job and the contribution it makes in the total organization should be given. The orientation program should emphasize the prestige and responsibility of the worker as the center of interest. This is the first opportunity to reference the training to the worker's adjustment, and because it is the initial exposure of the worker to the new and unfamiliar working environment it is an extremely vital adjustment.

The process of orientation, however, does not end with the initial adjustment but is continuous thereafter. Continuous orientation directed toward the improvement of the business through general employee training in public relations can be given. Such topics as the origin and organization of the business, the needs filled by the product, the services rendered to the public, the firm's policy relative to quality and price, and its techniques of dealing with the public will improve the employees' on-the-job relations with customers and in addition will favorably influence public confidence through the employees' off-the-job social relations. One of the inevitable results of this continued orientation is an increase in worker satisfaction eventually reflected in greater job proficiency.

Each time there is a major change in the organization, whether from technical advances, administrative adjustment, economic dislocations, or whatever cause, there is need of orientation through which the facts are made known to all employees. These facts should deal directly with the change in terms of its possible effect, favorable or unfavorable, upon the worker's status. Whenever a change that is going to demand worker adjustment is foreseen, the readjustment of the worker should begin immediately. He should be informed of the causes leading up to the change, the effect the change will have on the methods, processes, and products of the business, and the effect it will have on his job, the use of his skills, his security, and his pay. He should be informed of the readjustment that can be effected through training in order to retain his services and continue his security, and the requirements in time and effort the readjustment is likely to entail. He should then be given every opportunity and every encouragement possible to contribute personally to the problems arising from the transition. He should be made to feel and to accept a personal responsibility—a responsibility to achieve his own readjustment, the readjustment of other workers, and the necessary changes in the physical plant.

Broadening Training for the Man on the Line.—Although, after orientation, the development of skills is one of the most important phases of industrial training, it needs no emphasis here because it already forms the core of most training programs. Other emphases, less well recognized, deserve consideration. One of these is the need of broadening the training for the man on the line, for the person actually concerned with the routine mechanics of production.

In the past the man on the line has been the human robot, on whom various mechanical and psychological pressures have been centered from time to time in an effort to squeeze out additional output. His is a monotonous, repetitive task, the performance of which tends to deaden the initiative and dull the ambition. His attitude toward his work frequently takes the form that the job is a necessary task providing food to eat, or that it serves as a means of obtaining money for indulging and satisfying more important nonwork interests. Sometimes his outlook never reaches beyond the routine performance of the job, an attitude of "just getting by" in fulfilling his obligations to his employer. This worker forms a large proportion of the workers in American industry today. He is to be found among those who are just now in the process of learning the importance to be attached to the role they play in American industry. His training is a problem in the development of attitudes and not of skills.

Certain notions concerning the trainability of this type of worker need reexamination. According to Cushman he is to be placed in the 90 per cent of workers who have no promotional potentiality.[1] He is to be considered somewhat defective in initiative and ambition. He is supposed to lack aptitude and ability for growth and improvement. If these interpretations are accepted as true, they form an indictment of American industry's insight into the fundamental modifiability of human nature.

The point of view being championed in this chapter is that these interpretations do not correctly reflect the potential modifiability of the ordinary working man. In the first place, promotion is not something to be restricted to the top 5 or 10 per cent of workers; changes of a promotional nature should reach right to the bottom of the ladder. The concept of promotion needs to be broadened and more generously utilized in stimulating the improvement of the individual on routine work. In the second place, initiative and ambition are not solely conditioned upon invariable psychophysiological structures but are subject to change through education. Thirdly, the presence or absence of aptitude and ability can be judged only in terms of specific job tasks. Every worker possesses talents that can be exploited. The functions of training should be to discover these talents and then train the worker in that job which requires the development and use of his particular talents.

The Clinical Approach.—A further emphasis that is gradually assuming greater importance in industry might be termed the *clinical approach.* In effect it is individualized training, broadened sufficiently to encompass all phases of the worker's behavior.[2] It is directed toward avoiding the waste of human effort and enterprise that results from discouragement, worry, failure, and kindred maladjustments. It is remedial training in that it attempts to discover sources of trouble and offers remedies through personalized instruction for eradicating them.[3] It views human nature as essentially modifiable within broad limits. It is not resigned to accepting personality characteristics of long standing as unchangeable. Habits of neatness and cleanliness, social reactions of tolerance and cooperation, etc. can be developed whenever there are sufficient incentive and recognition of need, regardless of the age of the worker.[4]

This form of clinical training requires a great deal of psychological insight into human nature. It frequently arouses an initial opposition from the worker, and only in the hands of an expert can it be successfully developed and applied. The need for such training and the possible success that results from it are well established, and it therefore merits a wider utilization by industry.[5]

SOME PROBLEMS FOR MANAGEMENT

A New Obligation.—In recent years employers in American industry have come to accept full responsibility for the conduct of training rather than leave it to the free choice of a few employees with ambitions to be promoted. This step was made almost from necessity in order to cope with the problems arising out of the swiftly moving changes of the last 20 years. Today the problems facing the employer are even more disturbing, and training again must be exploited as one element in the solution. Developments of the future will demand just as much progressive change in the thinking and attitudes of the worker as in those of the employer. The socio-industrial environment is constantly undergoing change, and the worker must keep pace with it. The question may be asked: does management hold the key to the solutions of many of these vexing problems in the potential social and personal development it can achieve in the worker by means of training programs? The future may find that the employer will accept as an obligation the task of assisting in the continued growth and adaptation of his employees. It is in contemplating the possibility of this development that some of the suggestions to follow are made.

Establishing an Over-all Training Policy.—The most important problem in training facing management is the establishment of a sound over-all training policy within the framework of which all types of instructional programs can be efficiently executed.[6] The first requirement of such a policy is that it should have a broad base. It must not be limited solely to the improvement of job responses but must also reach out to every situation containing factors affecting job performance. It must not be restricted to workers of superior talents but must reach all levels of aptitude. It must not only provide for those with interest and drive to get ahead but must also offer stimulation that will arouse initiative and ambition in those more lethargic.

The policy must recognize and champion the principle of the conservation of human productive power. It must include in its criteria the satisfaction and adjustment of the worker, as well as the traditional objective of effective production. It must allow for adapting the methods of work to the personal idiosyncrasies of the workers, as well as encouraging the use of correct methods by all workers. It must recognize limits of tolerance in the psychophysiological structures of the worker.

To be successful the training policy must provide the necessary encouragement and incentive that will instill desire and drive in the participants, regardless of the nature of the program. This can take several forms of expression. It must include management's moral support of training. It must include the fulfillment of promises connected with posttraining status. It must include concrete rewards. It must include a systematic and long-range promotional policy, one providing for the expression and development of talent at all grade levels. It must include the active and continuous participation of both instructor and trainee in the establishing of training policies.

Coordinating Training with Need.—In addition to the foregoing general features of the training policy, there are many special problems for which solutions must be provided by management. One of these is the coordination of training with need. This requires foresight and long-range planning. Instead of waiting for the dislocation anticipated from a technological change to occur before taking remedial steps, management should evolve a solution, set up a training program, and have potential adjustments in progress before the change occurs. Instead of looking around for a worker to promote to a given vacant position, management should have foreseen the vacancy and should have trained a worker, who is then ready to take over the position as it is vacated.

Providing Training Personnel.—A further problem is to establish a sound department or organization responsible for executing the training. In any large organization, training merits a full-time director with assistants. In smaller companies, when training has to be combined with other duties, the officer should not treat it as a side issue or extra responsibility but should allocate to it time and attention as with any other duty. Regardless of the nature of the organization, management must make certain that the training officers are assigned the authority and responsibility they require in order to coordinate their activities with those of other departments.

Providing Physical Facilities.—Physical facilities for training must be supplied. Here the policy should not be one of penny pinching. As rapid learning of correct work methods is the goal of much training, any provision of space, machinery, or materials facilitating this goal will be paid for in the long run from the faster rate of learning and the improved retention that will result. In terms of physical equipment the training department should not be forced to play the role of the stepchild. Time for training is another provision that must be made. The amount of time off from the actual job for training purposes will vary with the nature of the work, and no general rule is applicable. It is suggested, however, that there be less emphasis on getting the trainee into a productive job, and more emphasis on the learning of correct work habits and attitudes.

Further problems concern the provisions for the selection and training of instructors, and for the selection of the trainees. These topics will be considered in later discussions.

STEPS IN SETTING UP A TRAINING PROGRAM

The following steps in establishing a training program have gradually taken shape over a period of many years. They form a core of general principles that should find application in varying degrees in every type of training situation.[7]

Determining the Area for Which Training Is Needed.—Vacancies in positions at all levels are continuously occurring from deaths, resignations, transfers, and promotions. Changes in the nature and amount of work accompany all technical improvements, expansions, and reorganizations. To a large extent, most of the manpower needs arising from the foregoing conditions can be foreseen, and instructional programs can be arranged to provide a source of adequately trained personnel. Interviews, questionnaires, and surveys are the commonly used means of learning in what spheres training should be emphasized. The sources of maladjustment of individual workers can be determined through clinical interviews.

From this step the limits and extents of the training can be roughly outlined. It is the first sizing up of the training needs and is carried out sufficiently intensively to provide the basis for deciding whether or not some form of training is demanded. It can provide information for clarifying the general purposes to be achieved and the general principles to be followed in achieving them. The exact nature of the instruction and the specific topics, fields, or skills to be covered are determined in the next step.

Conducting Analytical Studies of the Specific Needs within the Area.—When motor skill in a certain job is to be developed, this step requires that a job analysis be conducted.[8] Procedures for making a job analysis have been described in Chap. II. All that need be said here is that such an analysis should be thoroughly conducted in order to provide an accurate basis for determining the nature of the specific areas in which training procedures are to be prepared. It should serve as a means for arriving at correct movement patterns and temporal sequences of response that the trainee must learn.

Similar analytical studies should be conducted for work involving mental skills and other types of mental abilities.[9] For example, in a program of training for supervisory positions, analyses should be made of the difficulties, responsibilities, and social relationships encountered in performing supervisory work. In the area of the worker's personal problems, analytical study of the psychological factors conditioning the maladjustment is necessary before the exact nature of the training for readjustment can be determined.

Devising Sound Training Units.—This step concerns the arrangement of the materials, procedures, and skills to be learned into units that are readily assimilable by the trainee, and determination of the sequence and timing of these units so that rapid learning will result.[10] Endless tasks are monotonous and result in boredom. Breaking the learning into units enables the learner to set up a sequence of goals. As each goal is reached, the resulting feeling of achievement serves as added motivation.

In group instruction, recognition must be given to the principle of individual differences in adjusting the units to the aptitudes of the members of the group. In the beginning of learning, the units should be short and easy of accomplishment. A good start is essential to morale, and it will tend to prevent any blocking of learning with its attendant feeling of discouragement. When possible, the units should be arranged in increasing order of difficulty so that early achievement will aid in preparing for later requirements. In reference to instruction and supervision of these units it is well to follow the rule that guidance has its greatest beneficial effect when inserted early in the learning of a performance.

The application of the foregoing points in arranging the training schedule for a motor skill is readily appreciated. Their application to the learning of mental skills, of judgmental and social reactions, and of individual adjustive responses is less evident. In general, however, these principles will prove efficacious in these other fields of learning

Standardizing Procedures and Allowing for Flexibility.—Because so many procedures of work in present-day industry are standardized, training officers must see to it that the employees learn accepted standard work methods. This is very difficult to accomplish unless the complete procedure to be taught has been reduced to writing and thoroughly impressed upon the teaching staff.[11] In this formal description it is necessary to include any variations in emphases or methods that might take place during learning. For example, the relative importance of speed and accuracy of performance should be determined and put in the written description, and to this should be added certain variations in emphasis upon speed that are conducive to learning the correct responses. In the early stages of learning, less emphasis on speed and more emphasis on accuracy results in faster progress.[12] A schedule of progress having goals to be met at different stages in learning is a means of keeping the trainees highly motivated, and it also affords a measure of the extent to which the training is achieving the desired ends.

The enforcing of standardized procedures can be so rigid as to run counter to the principles of individual differences and individualized training that have been discussed. In the statement of the company training policy and in the description of the training procedures due allowance must be made for adapting the work methods to the aptitudes and limits of tolerance of the worker. This does not mean the sacrifice of correct work methods if adequate procedures have been used in the selection of the trainees.

In the remedial training devised for furthering the personal adjustment of the employee, standardized procedures should seldom be used. Here the specific needs of the individual are to be served, and this can best be accomplished by organizing the training around the specific conditions of each case.

Selecting and Training Teachers.—In connection with this step the reader should consider the discussion in the preceding chapter on the importance of teaching in training, in which some of the contributions of good teaching were outlined. Mention here should be made of the general weaknesses of the older method of assigning the teaching to a straw boss, junior executive, or the highest producing worker, without previously making a thorough study of this person's interest in and qualifications for teaching. To know a procedure, or to be able to execute a procedure effectively, is only one requirement for teaching it. To be qualified in technical matters does not mean that one is qualified in human relations. To have an abundance of job skill and knowledge does not guarantee insight into the understanding of the problems encountered by trainees. To come up through the ranks to the point of being an expert producer does not necessarily mean that the most effective methods of work have been learned. To have drive toward intensive application of one's talents carries no assurance of possessing ability to arouse initiative and drive in novice workers.

The argument being made is not that such factors as job skill and job knowledge are not essential requirements, but rather that they fall far short of being sufficient requirements for teaching.[13] Full release of energy can only come when the worker has confidence in himself, when he is convinced that the program is a means of increasing his own stature and security, and when he identifies himself with the program through personal understanding and free choice and not through blind faith or coercion. It is these more intangible, but nevertheless vital, objectives of training that are beyond accomplishment unless there is expert teaching.

Teachers themselves must be trained.[14] Seldom will a worker be found who has had extensive training in both performing the job and teaching the job to others. The training may require instruction in teaching procedures having a general application, or instruction in specific procedures to be used in a given program. If the program requires the use of more than one teacher, considerable instruction must be given on the necessity of every teacher utilizing the standard procedures adopted for the program.

When training involves problems in personal adjustment, teaching, for the most part, gives way to counseling and advising.[15] Again it is of vital importance that the person be highly qualified for this type of training. Seldom will a foreman or supervisor be found who can do a completely satisfactory job of counseling, and in most instances better results will be achieved if the counselor is specially trained in clinical techniques. This is a field of training in which professional preparation is mandatory.

Selecting the Trainees.—From the job analysis and other analytical studies, the requirements of the job will be made known. In turn these requirements will furnish a basis for estimating the abilities and personality traits required for successful performance of the job. Various selection devices, such as tests, ratings, inventories, and interviews, can then be utilized in devising a method for choosing the trainees.[16] These selection procedures have been considered at length in previous chapters. The technical complexity of the method will vary with the nature and complexity of the job. Certainly for the higher level jobs, in which foresight, judgment, acceptance of responsibility, and the like are of primary importance, it is necessary to take advantage of the best methods available for choosing qualified personnel for training. It will also pay dividends to use adequate—although not necessarily complex and costly—selection methods for securing the trainees for jobs at other less complex levels.

The widely accepted method that uses the personal judgment of the foreman or straw boss for selecting trainees needs examination. It should be apparent that the success of this method is a direct function of the psychological insight of the straw boss. Certainly such insight as is required for correctly judging the ability, interests, adaptive capacity, and promise of a worker is not to be found in any profound amount in the average foreman. It is also difficult to see how favoritism and personal prejudice can be avoided in the method of using foremen to do the selecting. Inasmuch as scientific procedures are now available and technicians can be trained to use them, there is little need for continuing with the older method.

The first step in the selection procedure should be the promulgation of facts about the change for which the training is being organized. It cannot be overemphasized that the employee must be convinced of the necessity for the change insofar as he is personally concerned, and he must be assured of the advantage the training will bring to him.

Without this basis for establishing personal motivation the chances are stacked against the success of the program. This is true not only where the development of skill is concerned but also in the field of personal adjustment. Little can be done to improve adjustment until the individual understands the contemplated change, accepts the need for the change, and is convinced that he should try to effect the change.

Providing for Training Facilities.—This step has been considered in sufficient detail elsewhere and needs no further elaboration here.

Evaluating and Measuring the Achievement from Training.—The effectiveness of training should be evaluated just as effectiveness is measured in any other industrial function. In the past, management frequently has been satisfied with rather casual and perfunctory reports. Few reports can be found in which thorough and systematic measurement of training progress and achievement has been accomplished.[17] As the findings obtained in the evaluation serve several important functions, it merits the careful attention of those responsible for organizing training programs.

The needs for measurement are many. In the beginning the initial aptitude of the trainee should be known in order that the learning tasks can be adapted to his power of assimilation. At different stages during the training, achievement should be measured in order to determine the progress of each learner. Frequently, evaluation before and after the training in a given response reveals pertinent information both about the trainee's execution and mastery of the response and the effectiveness of the training methods. Detection of incorrect habits of response and the use of ineffective methods is often improved through measurement. As the trainee reaches higher levels of proficiency it is necessary to determine if his proficiency merits his graduation from the formal program. Lastly, the over all accomplishments of the training program should be evaluated in order to compare its cost with the resulting improvement it effected. Such evaluation should be made immediately at the end of training and again at a later time after the workers have had an opportunity to demonstrate their ability on the job.

The specific methods and techniques to be used in effecting the measurement depend upon the nature of the training and the purpose for which the evaluation is needed. Most of these methods have already been discussed elsewhere in this book. When the behavior to be measured can be demonstrated in a test situation, written and performance tests can be used. For the less tangible responses, ratings and check lists serve the purpose of getting quantitative information. Further important information can be obtained from production records, especially if these records have been kept before as well as after completion of the training project. Any criterion that reveals the proficiency of the trainee can be utilized for evaluating the program.

Reports of progress or achievement resulting from the learning should be made available to anyone in the company who can profit from the information. Too frequently the reports are restricted to higher executives. It is as if the learning had been accomplished for their especial pleasure. Progress reports can serve as strong motivators to the learner and therefore should be compiled in such a form, and include such explanations and interpretations, as will enable the trainee to receive the maximum benefit. Very frequently such reports are revealing of the strengths and weaknesses of the employee, and this information can be used later in getting him correctly placed in a job. Training officers and instructors, particularly, should find the reports of training success of vital importance in their work.

Following up the Results of Training.—Even the best training does not obviate readjustments in the learned performance after the trainee begins to function in the actual job situation. The new worker frequently is in need of further supervision and guidance in the process of getting adjusted to the job, and the training program should make provisions for assisting the worker after completion of the formal training. In the case of complex psychomotor performances it cannot be expected that the novice worker will perfect his responses in the course of a few weeks of training to a point where they approach those which an expert has developed over years of work at the job. Such complex skills will continue to develop over many months of working on the job. Left by himself the worker might develop incorrect modes of response that would negate some of the learning accomplished in formal training. Training officers should be interested in following this later phase of learning.[18]

In the field of personal adjustment, follow-up procedures are essential, since it is through follow-up interviews that much of the instruction is given. As in other forms of training, the employee must develop his new responses by practice. Sometimes such practice extends over many months, and follow-up interviews serve as means of evaluating the adjustment, detecting and correcting any erroneous reactions that might be present, and enabling the counselor to make suggestions that will bring about an integration of those responses that will achieve maximum adjustment.

TYPES OF INDUSTRIAL TRAINING PROCEDURES

For many occupations in industry the formal training requirements are fulfilled in grade schools and high schools, colleges and universities, and business and vocational schools. The following paragraphs are concerned only with procedures that industrial firms have devised and set up to supplement the formal school training possessed by the novice when he enters employment. Space is not available to describe all the many diverse types of training that industry, at one time or another, has found valuable. Instead, attention will be directed to an evaluation of a few forms that have a wide application in present-day business and industry.

On-the-job Training.—This is by far the most frequently used type of training. Some investigators estimate that from 75 to 90 per cent of all organizations find it a useful and practical means of training new employees.[19] The training is accomplished at the scene of the work while the trainee performs the actual tasks comprising the job.[20] Production starts when training begins. As can be expected, in the beginning of training output is low. In the skilled crafts considerable wastage also occurs. The method has found application in a wide range of jobs, including executive and administrative positions,[21] clerical and office jobs, bench and machine work, and jobs requiring little or no skill. The person selected for the instruction varies with the type of work. He may be an executive, a foreman, or simply a proficient worker.

The method has its favorable and unfavorable points. It tends to stimulate high motivation. In starting immediately on the job the trainee realizes one of his strongest immediate goals, which is to start producing. In dealing with the actual tools and methods of the job he gets the feel of the "real" things. He recognizes himself as performing the same tasks as are the other workers around him and thus gets added security from identifying himself with the group. Psychologically these features are usually positive factors in the personal adjustment of the trainee.

It is possible, however, for learning to be detrimentally influenced. The trainee's introduction to the job may be too abrupt, the initial tasks being too difficult for him to comprehend and master readily. The social motivation of his fellow workers may overstimulate him in the direction of speed and thus interfere with rapid learning of the correct response. Unfortunately the trainee may be placed with an instructor who is not particularly skillful in adjusting the tasks to the trainee's assimilative capacity or in detecting his errors and weaknesses. The instructor may not be particularly enamored with his responsibilities as a teacher and thus may limit his instruction to verbal abuses after the trainee has committed mistakes.

For the most part, these and other limitations of the method are avoidable when the steps for setting up and conducting a training program are carefully followed. Through accurate job analyses and methods studies, the correct methods of work will be established; units of work will be organized and a schedule drawn up that adapts the tasks to the trainee's power to learn; and he will be assigned to a teacher whose interest and training as well as job experience and skill will enable the trainee to get the type of instruction that will make for individual adjustment.

Vestibule Schools.[22]—As the name implies, this method provides facilities for training the new worker in needed job skills before he actually enters into the productive situation of the job itself. It attempts to train the worker in the shortest period of time by giving him practice on the same machines and methods he will encounter when he goes on the job. Sometimes the training for all jobs is done in a central location. This is the practice followed when the number of jobs for which instruction is needed is small, and when the number of employees to be trained for any one job is small. If the personnel requirements for a department are large, the actual training may be conducted within the department but under central supervision. Because of the expense involved, this method is used ordinarily only by large organizations.

The method has several important points in its favor.[23] Its major advantage is that the vestibule school is primarily organized to provide effective instruction and not to contribute to production. This makes it possible to practice more intensively those psychological principles that facilitate the learning and retentive processes. The progress of the trainee can be followed more closely and evaluated more accurately. The instructors can be selected with greater care, and their sole or major responsibility can be made the conduct of the training courses.

Other advantages accrue from the school type of organization followed. The school can serve as a source of information about the range of knowledge, aptitudes, skills, and traits possessed by the trainee. Here is a situation where he can be tried out on more than one machine or in more than one method or type of work. Also, because of his intercourse with other trainees, his social adaptability can be observed. When instructors are skilled in methods of evaluating these characteristics, they obtain a considerable amount of information that proves useful in effecting a correct job placement of the trainee.

Certain characteristics of the vestibule school are conducive to high motivation of the learner. He is going to school on company time. He is working on the same type of machines he must operate on the job. He gets the opportunity to try out for more than one job. All these features stimulate his interest and desire to make good. His adjustment to the job, following formal training, is made easier. In the school he has automatized to some degree the reactions he must later use, and this proficiency and the confidence it engenders better enable him to face the unfamiliar and distracting aspects that are met when he begins his productive work.

The vestibule school not only serves to train the new employee when vacant jobs need filling, but it serves an additional function of in-service training. When work is uneven in different departments, and certain ones find it necessary to consider the release of some of its members, it is possible to enroll these employees in the school and train them in jobs for which the demand is greater. Likewise, when procedures or methods of work change sufficiently that the adjustment of the workers would be facilitated by a formal training course, the school can serve this purpose.

The pedagogical limitations of the vestibule school are not serious. One criticism is that the method does not duplicate the natural or "shop" atmosphere of the job. It would appear, however, that most of the stimulating features of the work environment can be reproduced in the school, and the aspects that serve as distracters can be minimized, and thus an approximation to optimum conditions is achieved. A second limitation that is sometimes offered is that there is not sufficient emphasis in the school on the production features of the work. This is not a serious criticism of the method, since the correct attitude toward these features can be molded by expert teaching. Furthermore, during the later stages of training in some schools the learner may actually produce usable goods.

The method is somewhat limited in respect to the level of the jobs to which it can be applied, being less useful at the higher executive and administrative levels than at levels where the jobs are mainly comprised of mental and motor skills. A further restriction is imposed by the cost of organizing and maintaining such a school. It is only because of the large number of employees to be trained, or the large number of jobs requiring trained personnel, that a concern can finance the specialization that the vestibule school calls for, and it is in this characteristic of specialization that most of the advantages of the method are found.

Company Training Schools.—The characteristic that differentiates this school from the vestibule school is that the training in the company school is alternated with practice on the job. The trainee, after he has learned certain phases of job performance in school, usually working with the same materials or machines as are used on the job, is then transferred to the actual working environment where he can put into productive use the things he has learned. When he has demonstrated an acceptable level of proficiency, he is put back into school, where he continues with further formal learning. This alternation between classroom and job continues until all aspects of the work have been satisfactorily assimilated in school and practiced on the job. The Ford Training School is a good representative of company schools.[24] It was organized in 1935 and is primarily concerned with the training of skills.

Most of the advantages of the vestibule school also are characteristic of company schools. In addition many large concerns have expanded their company school to serve the functions of general educational improvement. Courses are organized at different levels covering a large number of cultural and technical subjects. The employee can get a liberal education at the high school or college level, and college graduates can continue their study at higher graduate levels. The chief limitation of the method is its restriction to large companies because of the great expense it entails.

Apprenticeship Training.—Apprenticeship systems in the early years of American industry followed closely the pattern developed in Europe. A young man was bound over to his employer by his parents or guardian through a written contract, which required that he would spend a stated number of years working for the employer in exchange for the training he received in the trade. Over the years many changes have been introduced in an effort to remove certain obnoxious features, such as the loss of freedom of the worker and the prolonged time he spent in learning the trade.

Moore classifies present-day systems into three kinds.[25] In one system, private industry provides both the formal classroom training and the training on the job.[26] In the second, industry cooperates with vocational and trade schools in the training program. The schools provide the formal classroom instruction, and the industrial organizations supply the practical training on the job. During the training, the organizations guarantee the apprentices a minimum wage and guarantee the successful ones a job at the completion of training. In the third type, both the formal and practical training of apprentices for a given group of firms is assumed by some agency, such as an institute, especially organized for the purpose. Firms utilizing the service cooperate with, and contribute to, this agency in various ways. This system has grown in popularity with small firms, which cannot afford separate training programs for each of their several trades.

To be successful an apprenticeship system must have certain features.[27] There should be certain objectives of training set up at the beginning in which there is an explicit statement of the particular skills to be developed and the degree of proficiency that will be set as a goal for attainment. The instruction should be organized into developing units, based primarily on the units of skills or jobs into which the trade naturally is divided. There should be an ascending scale of these units, and promotion should be made from one to the next as the apprentice qualifies. Certain standards of proficiency should be set up, on the attainment of which promotion depends. The instruction should be arranged in an organized form, with manuals, texts, and demonstrational materials that will enable the trainee to get a firm grounding in the theoretical and scientific aspects of the trade. There should be ample provision of job experience for developing the practical phases. There should be a fair wage provided for beginners, which is increased as the trainee progresses in his mastery of the trade. Promotion through the ascending units should be based upon the attainment of certain standards of proficiency and should not be based upon the length of the training period. The written contract should guarantee both employee and employer a fair return for his contribution: to the employer a sufficient amount of productive labor from the apprentice to pay for the instruction supplied him; to the apprentice, adequate provisions for learning and developing proficiency in all phases of the trade in return for his productive efforts. In addition to these features the training program should contain adequate measures for selecting the trainees and for selecting and training those who are to act as instructors.

When the foregoing conditions are met, the evils of the older apprentice systems, which are still condoned in some industries, are avoided. Undue lengthening of the training period in favor of the employer, which is still frequently found, is avoided. The freedom of the apprentice is not severely restricted. The return to the apprentice in pay is sufficient and, when based upon proficiency, has a favorable effect upon motivation. The shortening of the period of training, as a result of being based on individual proficiency, reflects to the credit of the employer because the apprentice's productivity reaches higher levels in a shorter time and with less training cost.

Lecture Method.—Under this heading are included all meetings called among workers for the purpose of verbally presenting information in which one or only a very small number of those present actually contribute to the dissemination of the material. The lecturer may be a member of the company, usually a supervisor or executive, or he may be a guest lecturer. In either case he is presumed to occupy a position of authority or prestige that entitles him to address the group. The method is frequently used because of the ease and rapidity with which the information can be placed in the hands of those needing it. It is economical of time. Another feature is that all trainees get the same information and get it at the same time.

The method has several limitations.[28] It is restricted to the type of training involving the understanding and learning of verbal material. It is not very successful when used for disseminating information to workers in the jobs of lower skill, because these workers are unaccustomed to concentrating and learning in this type of situation. The success of the method depends too largely upon the ability of the lecturer. If he talks too rapidly, if he uses language above the understanding of the listeners, or if he fails to arouse their interest, then it is doubtful if the lecture has succeeded. Usually there is no permanent record made of the information dispensed, and no attempt is made to measure the outcome. It is impossible then, except from hearsay information, to know how successful a lecture has been. If there are several lecturers during the same meeting, or if several lectures are given in a series, there is seldom any attempt made to unify the different points of view presented. The trainee is then left with several kinds of unrelated and only partially digested information. It is doubtful therefore that this type of instruction should be encouraged. Lastly the method depends primarily upon authority for getting over the points to be learned, and this as has previously been noted is psychologically unsound. The method does serve a useful purpose when little learning is involved, *i.e.*, when the purpose is merely to circularize the employees on points of information.

Conference or Group-discussion Method.[29]—As the name implies, this method requires the participation of the members of the group in a free exchange of opinions, ideas, and criticisms in thrashing out common problems. Usually the group is small. One member acts as a leader in getting the conference under way and in stimulating all members to take an active part in the discussion. The agenda are frequently prepared ahead of time, and the discussion revolves around the problems that they present.

This method has been substituted almost completely for the lecture method on the lower executive and foremanship levels. It has the advantage of stimulating active participation of all the members. In the free exchange of opinion many points of view are championed and criticized. When the problem involves a specific local condition, this method offers a higher guarantee of reaching a successful solution than if only one person does all the thinking, as is so frequently the case in the lecture method. This active participation also makes for better mastery and retention of the material learned.

The agenda are usually sufficiently flexible that participants are encouraged to bring up problems troubling them, and members frequently use the discussion as a means of revealing matters in need of further thought and analysis. There is systematic thinking about the problems considered, and direction is given to the whole discussion. As a result of the free interplay of ideas it is usually possible to iron out differences and closely approach common agreement. This is important where matters of company policy are concerned.

The method is conducive to a high level of cooperation and morale among the participants. Each member has the opportunity of contributing to the program and therefore identifies himself with it. Each sees the necessity of compromise, and each comes away from the discussion with not only a greater understanding of the problem but also a greater appreciation of the problems and points of view of the other participants. These features of the conference method are psychologically basic factors in the development of mutual trust and cooperation.

The method has few disadvantages. The most serious one is that as a training device it is rather slow and therefore somewhat costly. Insofar as the function of disseminating information is concerned, it is far more expensive than the lecture method. In regard to such features as getting troublesome problems out in the open where they can be discussed, arriving at a solution after critical debate, stimulating agreement through active participation, or getting everyone concerned identified with the outcome the method is as rapid as any yet devised. These are accomplishments usually far more difficult to achieve than increasing the fund of the employee's information or developing his mental or motor skills, and the price that has to be paid in the slowness of the method is to be considered very reasonable in the light of the potential returns. Other limitations are usually a function of how the method is utilized and can be obviated when the requirements below are met.

There are certain features of the conference method that should be seriously considered when it is being utilized in training. These correspond somewhat closely to some of the steps suggested for setting up any training program. The success of a discussion may well depend upon the leader. This is particularly true until the participants have become "discussion conscious." Therefore a wise choice of leaders is necessary. There must be objectives, plans, and agenda. Conferences often fail because there are no definite problems to discuss or because the problems presented are not of significance to the members. The agenda should not be too cut and dried and should be flexible enough to encourage discussion of problems related to the ones in hand. In a series of conferences there should be continuity from one meeting to the next, and this continuity should be apparent to all participants. There should be a definite temporal arrangement for the conferences, and this arrangement should be adhered to. Efforts should be made during the progress of the program, and after its completion, to evaluate its success in achieving the objectives for which the training was organized.

MAJOR FIELDS OF TRAINING IN INDUSTRY

In the following pages a consideration will be given to three fields of training: training of line and nonsupervisory workers, training of foremen and supervisors, and training of staff officers. Obviously it is impossible in a short space to deal with all the problems and methods to be found in these fields. It is intended merely to acquaint the reader with problems typical of those encountered. Much of the material found in the earlier discussions in this and the preceding chapters has application to the points to be discussed.

TRAINING LINE AND NONSUPERVISORY WORKERS[30]

The Field.—This type of training includes instruction in mental as well as motor skills. The word *skill* refers to a performance that is somewhat routine in execution and, in its main essentials, varies within narrow limits. It may require the exercise of various types of judgment. To develop skill to a high level of proficiency usually demands considerable practice or sheer repetition of the performance. Mental skills include number manipulations, recall of numerical and verbal materials, perceptual discrimination, vocalization, sensory facility, etc. Motor skills include muscular reactions, such as finger, hand, arm, and foot dexterity, and acuity in the different senses, such as vision, audition, and touch. In addition the factor of judgment may be present. It is obvious that skills are to be found in nearly every department of a company from the clerical, filing, and bookkeeping skills of the head office to the bench, assembly-line, and machine skills of the factory.

Some Problems.—Although the general problem of learning the best way to perform a job is present in all fields of training, the discovery and development of the best methods for doing work have had greatest emphasis and achieved greatest success in the field of skills. It has been a central theme in this type of training for over twenty-five years. Here the reader is referred to the whole field of motion analysis, which has centered attention on correct methods of work. Of less importance in the past have been the problems of orientation, attitude and incentive formation, and general educational advancement.

Methods.—The methods for accomplishing the training have varied with the nature of the specific problems. Training on the job, vestibule and company schools, apprenticeship systems, and lectures have all been utilized.

In training skill, job analyses and motion studies afford a basis for determining the job tasks and for devising the units of instruction. These are written up in comprehensive form. The instructors selected for the program are trained in the standard units and methods to be developed. When necessary, each trainee is given individual instruction to make sure he understands the correct nature of performing the response he is to learn. The simpler components are taught first. In the early phases of training the emphasis is upon accuracy of performance rather than speed.

After the trainee has learned to perform a given response component correctly, he is practiced in it until he achieves a creditable effectiveness. He is frequently checked against the standards set up on the basis of time-and-motion studies, and his progress carefully watched. When he attains the standard set for a given suboperation, he is given another component. He then continues to progress through the increasingly difficult units. The standards set for the separate units demand correctness of response at only moderate speed. Practice for speed usually comes after the sequence of movements or reactions making up a larger coordinated response are learned well. Formal training often ceases at this point, and the trainee is placed on the job.

Various wage-incentive plans in the form of graduated wages or bonuses are used to maintain motivation at a high level. During the learning, trainees are given special attention when they encounter serious problems, and occasionally some may be discharged during training when it is felt that they are not adapted to the particular job. Sometimes follow-up studies are made of the trainee after he has been on the job a short time, and these provide a means for correcting any faulty reactions that may be in process of forming. Occasionally he may be placed back in formal training if his responses are sufficiently defective to warrant further supervised instruction.

The foregoing statements briefly describe training programs of superior caliber. It is not to be understood that all organizations use such sound procedures, but steady progress in this direction is being achieved. More attention should be paid to the abilities and traits of the individual, and attempts should be made within limits to fit the work to his limitations. Greater progress can be made in training with regard to personal incentives and individual initiative. Further efforts should be made to keep the worker oriented in reference to company policy development and to encourage his participation and contribution in this direction. This appears to be one of the trends that training must take if the complex problems of the future are to be satisfactorily solved.

TRAINING FOREMEN AND SUPERVISORS[31]

The Field.—Foremen and supervisors at the junior levels are considered the outposts of management. They have been called the "fingers and hands of the managerial arm." They occupy a very responsible position, for they must identify themselves with the aims of management, on the one hand, and with the workers' needs, on the other. They are the mediators who, in large measure, determine the accuracy with which the objectives of the two groups are brought together and amalgamated into a common progressive purpose.

Some Problems.—A consideration of some of the functions of the foreman or supervisor will help to point up the directions in which training must go if he is to be equipped to discharge his responsibilities efficiently. The foreman frequently does the actual selection of the worker and gives the final approval of those who are to be hired. In this function he is supposed not only to know the fundamental human abilities and traits that are essential to success on the job, but also to be able to detect in others the possession of these qualifications.

The orientation and training of new workers are usually assigned to him. In this role he must be the teacher. It is assumed that he understands the necessary facts about the company, its products, and its policies to be able to acquaint the novice worker with the setting and background in which the job is to be found. It is further assumed that he possesses the ability and personality characteristics required to mentor his new subordinates successfully.

Since the foreman or supervisor often exercises the power of layoff, of establishing rates of pay, and of making recommendations for promotion and transfer, he is given the task of rating the effectiveness of his workers. The execution of these responsibilities demands that he possess something of the wisdom and the impartiality of the judiciary. The supervisor should understand how to evaluate complex behavior. He must be aware of the facts of individual differences and the problems involved in assessing these differences. The signs and characteristics of good and poor performance must be known so that workers can be rated in a reliable and valid manner. At the same time the supervisor must effect his ratings with fairness. This requires that the foreman or the supervisor be aware of the sources and nature of personal biases that affect his judgments and distort his ratings of workers.

The supervisor is the sympathetic listener and father confessor to his charges; he hears their complaints and grievances and offers advice and counsel. At such times he is called upon to exercise great tact and understanding and to make evaluations and judgments in interpreting the worker's problems in terms of management's policy. He is the truant officer for problem employees and is required to mete out disciplinary and corrective measures, which at times requires a considerable amount of insight into the underlying bases of human behavior.

It should be apparent from this brief survey of the supervisor's duties that he occupies a very important position in his company's organization. To qualify him to carry out these duties demands superior training in a great many kinds of skills, abilities, and traits of character and personality.

Methods.—For the most part the training methods used in developing the technical aspects of supervisory work have been those used in training skilled workers. Most foremen and supervisors gain their knowledge and skill in the technical phases of the job by coming up through the ranks. Methods used in the training of nontechnical qualifications are now just emerging from the experimental stage. Years ago the conception of a good foreman was a person who could make his subordinates produce, and the meaning of the word *make* was often interpreted quite literally. His function was to force production. Little was done in the direction of training the foreman in the use of psychological techniques in the handling of men. In recent years, although the broad objective of foremanship and supervision has not radically changed, the techniques and methods of executing the duties have gradually moved from those of threat and coercion to those of persuasion and leadership. During this transition a large number of training procedures have been tried out. Most of them have been some variant of the lecture or conference methods already described.

The pure lecture method was found unsatisfactory on several counts.[32] The method frequently failed because foremen, by and large, are not accustomed to learning by sitting quietly and listening intently for a long period of time. The thought and wording of the lectures were often in terms unfamiliar to the group. Usually the lecturer progressed at too rapid a pace for his audience. The motivation was sometimes at a low ebb because the participants were given no opportunity for asking questions to clear up points not understood, or to bring up related problems that to them had particularly pertinent relation to the topics presented. Members of the group had no previous knowledge concerning the nature of the topics to be presented and so came to the lecture "cold." As a result the unfamiliarity of the material covered by the speaker added to their difficulties.

The more successful variants of the methods that were explored seemed to be in the direction of the conference method. At the present time this is the most successful method in use for training in the nontechnical types of problems. When pure information of a simple sort is to be dispensed, the lecture, with provisions for questions, is usually successful. When problems of policy, methodology, and technique are to be solved, the conference method proves best. Here the most frequent objective is the *discovery* of the policy, method, or technique. Therefore the discussion is usually not centered on a cut-and-dried procedure but rather is centered on the discovery of a promising procedure and of shaping it to fit the problems involved. If a method is presented at the beginning of the conference, the effort of the group is directed toward improving and adapting it to the specific needs and to formulating the steps that will implement those conditions which will guarantee its successful utilization. The group learns through this process of thrashing out the solution in the give and take of the discussion rather than by the process of merely memorizing what they hear.

Conditions for Successful Conferences.—Certain features making for a successful use of the conference method have been found. Foremost is the fact that the method must be adjusted to the general intellectual level of the group. McMurray reports an instance of failure, of what appeared to be an excellently organized training program, due to not adjusting the difficulty level of the topics and discussions to the level of assimilative power of the members of the group.[33] A popular presentation was made of such topics as insubordination, failure to cooperate with new supervisors, how to deal with "problem" employees, leading versus driving employees, qualifications of a satisfactory foreman or supervisor, and others of similar nature. An evaluation of the program was made some time after its completion. It was estimated that not over 10 per cent of the participants actually made any practical use of the material that they supposedly had learned.

One step to facilitate understanding by the group is to make use of concrete examples drawn from experiences common to all the members. Another fact to have in mind in this connection is to keep the ability of the participants within a reasonably narrow range. At best it is difficult to adjust the level and speed of discussion to suit every individual participant, and it is doubly difficult when a wide range of ability is represented. The group should be kept small, a satisfactory number being about fifteen. One of the essentials for success of the method is individual participation, and this feature is lost for most of the members when the group becomes large.

A further facilitating condition is to have a prepared program, framed as a set of related problems, questions, or topics, which functions as a core around which the discussion revolves. It serves to give direction to the discussion and to prevent the argument from straying too far afield. It should be possible to give out the agenda for study previous to the conference and even to assign topics to individuals for preparation of short reviews or discourses. As pointed out before, the agenda should never be inflexible. These conferences serve a useful purpose in discovering problems and difficulties that no one foresees in arranging the program. Sometimes the greatest contribution of a conference comes from unearthing problems not foreseen in setting up the agenda, and for which further training is needed.

Conferences are frequently formed into a series, because in most areas of training it is seldom possible to solve a problem of any complexity in one or two meetings. It is essential therefore, that there be a continuity from one conference to the next. This is accomplished in part by a review, at each meeting, of the discussions and conclusions of preceding meetings.

Another important feature, which frequently spells the success or failure of a training conference, is the qualifications of the leader in charge of the group. He must be fully aware of what the objectives of conference discussion are and be thoroughly trained in the procedures of this particular method. Sometimes a good lecturer turns out to be an ineffective conference leader. The leader's task is to get the conference under way, to arouse every member to participate, to keep the discussion moving at a stimulating but not too rapid rate, to prevent the arguments from going too far from the central theme, and at the end to summarize the discussion by briefly relating the various arguments and noting the consensus. The one thing the leader should never do is to monopolize the time with an exposition of his own ideas.

Some Future Problems.—Some writers advocate the training of foremen and supervisors in the use of technical methods of selection. There is a question as to how far this training should go. Selection procedures have reached the stage in their development that requires considerable training and insight for their correct utilization. Far more knowledge and experience must be possessed than the average foreman has time to accumulate along with his other duties. This is not to argue against training foremen in the use, meaning, and value of technical selection procedures; it is rather to argue against leaving selection in his hands and trying to bring him up to a level where he can utilize present-day testing and statistical techniques. An alternative that seems to have a higher probability for success is to use specially trained technicians for this important function.

Training in conference discussion methods is one topic in which all foremen and supervisors should receive instruction. Most if not all of the knotty labor problems of tomorrow are going to be solved over the conference table. From present trends it would appear that the rank and file of industrial workers are going to take a more active part in policy making, and it is this group that the foreman supervises on the job. Conferences at this level might prove one way of getting the worker's notions and feelings verbalized, and of getting that interchange of opinion through which attitude toward company policy can be molded.

Training in conducting an interview should be given supervisors and foremen. The interest is not to make clinical psychologists of them but rather to give them some mastery over a technique that will be useful to them in their discovery and evaluation of workers' difficulties. There is no doubt that such problems must be dealt with, at least on the elementary level, by those in supervisory positions, and in the discovery of the difficulties in their incipient manifestations there is no doubt that the foreman and junior supervisor occupy a point of vantage. It is then highly probable that through improved interviewing technique he can perform this function more effectively.

TRAINING STAFF OFFICERS[34]

The Field.—In many functions no sharp differences can be noted between those assigned to foremen and junior supervisory officers, on the one hand, and those assigned to administrators and staff officers, on the other. Nor is it possible, when considering these two groups, to find many clear-cut and significant differences in the problems, methods, or techniques that make up their training programs. For the purposes of the present discussion the term *staff officers* will include the higher level supervisory personnel, such as heads of departments, divisions, plants, and other major units of an industrial organization. Staff officers mainly direct the work of supervisors of a lower grade rather than that of skilled workers. In addition to supervising, their duties include administrative and executive work of many kinds. Put briefly, the functions of this group are as follows: to interpret the fundamental policies of the company in the light of the objectives to be achieved; to develop, coordinate, and supervise an organization of trained personnel for translating these policies into action; and to devise and put in the hands of the personnel a set of methods and procedures that will enable them to carry out the policies and realize the objectives that have been set up.

Some Problems.—One of the regions in which training has been of particular service has been in interpreting company policy.[35] Employee dissatisfaction has frequently been found to stem from nonuniform interpretation and application of company rules. When policies are presented to staff officials in written form or by medium of lectures, many variations in meaning arise, and there is no opportunity to iron out the discrepancies and reach agreement. Extended discussion is usually required to solve problems of this kind.

An area related to the foregoing is that of lines of authority and responsibility. In large companies a given product may be worked on by members of several different departments, and problems of overlapping of control arise. Personnel sometimes are loosely assigned to more than one group or may work in more than one department, and difficulties of a jurisdictional nature arise. Frequently no adequate plotting of lines of authority has been done, and the learning of the boundaries of responsibility of officers and of departments has been left to chance assimilation. Again organized training has proved of great value, not only in instructing the staff personnel in the charted lines of authority and boundaries of responsibility but in the more significant role of discovering and charting lines and boundaries that before were never clearly marked. Certainly effective coordination between departments and between individuals depends upon each understanding his own responsibilities and also understanding the responsibilities of those with whom he must cooperate.

Executive planning is another field to which organized instruction has contributed. This may take many forms. It includes the improvement of work methods. The best methods for doing each task at the skilled level must be discovered, but this is not a problem that remains solved once and for all time. Whether the actual time-and-motion studies are done by staff officers or those at a lower supervisory level, the responsibility to see that a constant search is maintained for improved techniques and procedures is the responsibility of the staff personnel. Sometimes the training will involve instruction in time-and-motion-study analysis; at other times it is directed toward establishing correct attitudes and points of view conducive to finding improvements. This is a matter of attitude and of set. Although more difficult to develop than skills or knowledge, sets and attitudes can be learned.

Planning includes anticipation of future changes and progress. Staff officers are the planners of an organization. Technical improvements, plant expansion, and reorganization of departments or other groups to facilitate production are in their hands. To carry out such functions effectively requires the highest possible training in every phase of the industry. Under modern competitive business, survival often hinges on the discovery of new processes, new techniques, and new products, through which faster and cheaper production can be accomplished. Obviously a staff officer not abreast of the developments in his field cannot expect to contribute such discoveries. Much of this training is accomplished under individual initiative and on the personal time of the employee, but there are many points to which planned programs of instruction can make significant contributions.

As supervisors of other employees, staff officers are in need of training in leadership qualities quite as much as foremen and junior supervisors. When staff officers are promoted to their responsible positions, their qualifications in technical matters frequently are the main determiners in their selection. Many of them therefore are not acquainted with personnel techniques and consequently find courses in this field very profitable.

Methods.—Because of the more extensive educational background ordinarily found in this group, much use can be made of textual materials in the form of books, periodicals, manuals, and bulletins, which the employee can study on his own. Some of the training is also accomplished through specially organized classes. For many of the problems the conference method has proved the most profitable. It has been used at every level from top executives to the level of junior staff officers.

A training program is set up much like that already described for foremen. First the area of need is delimited. If the area is one of organization and coordination, then a job analysis or job specification is made. Each executive lists his duties, his responsibilities, and the difficulties he encounters in his formal and informal relations with his superior officers.[36] He meets with his subordinates, and through group discussion they break down each of the major working areas into its components. This breakdown at different levels continues to a degree that will permit the construction of a practical outline for each job. Sometimes a master list is then made for all executive positions at the same level of responsibility. These outlines are formed into an organizational manual, which can be used as a text in the training program.

The training is then arranged in a series of conferences.[37] First the top executives meet and through group thinking isolate and define the problems and consider possible solutions. At the completion of the deliberations, conclusions are framed, tentatively setting up the new policies. A brief report is made of the meeting, which is incorporated with the outlines for the use of officers of the next lower level. Similar conferences are held by these officers following the procedures just outlined. Conferences are then held at each successively lower level, with each participant knowing what the tentative findings of the higher levels have been, and each one having the opportunity to challenge and criticize what has gone on before. At the end of the series the training officer or a special committee integrates all the findings and prepares a statement of the new policies. It is apparent that this method utilizes many of the psychological principles already described as facilitating the learning process.

Some Future Problems.—There is no doubt that the training programs for staff officers set up by certain of the more progressive firms follow sound methods of scientific pedagogy, and these programs merit more extensive adoption throughout industry. In the future an emphasis likely to receive more attention in training is the responsibility of staff officers to establish company policy. The trend has been in this direction in recent years, but it can be safely written that at present the function of staff officers is still primarily one of interpreting the policies set up by the employer, and they have only a small voice in the origination and formulation of the policies. As they are given more responsibility in this direction it will be a function of training not only to instruct them in company policy but to set up conference discussions through which the most enlightened and progressive policies can be evolved.

The social value of industrial organizations is a further topic likely to occupy the attention of staff officers in the future and will require some systematic training. Again from the past a trend is observable in which, more and more, industry is contributing to the social good in other ways than employment, wages, and profits. The industrial unrest of recent years points to the tremendous social consequences that come from work stoppages, regardless of their cause. Society seems to have reached the state of demanding that a permanent solution be sought. Obviously it can come only through the cooperative enterprise of employer and employee. Regardless of what the nature of this cooperation will be, there is no gainsaying the fact that it must come through the educative process. Staff officers must play an important role through developing insights into the social implication of business policies and objectives. Training programs will provide the give-and-take situations from which can be evolved the insights that will work toward the advancement of the social good.

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CHAPTER XIV

ACCIDENTS AND THE SAFETY PROBLEM

The number of workers involved in industrial accidents is so astonishingly high that a person not familiar with the actual statistics undoubtedly would underestimate their frequency by more than one-half. The following tabulation shows the number of industrial accidents occurring in 1945:[1]

TABLE 85

Fatalities	16,000
Permanent disabilities	1,800
Partial disabilities	82,700
Temporary disabilities	1,902,300
Total disabling injuries	2,002,800

These injuries are estimated to cause a loss in full-time annual employment of the equivalent of 725,000 workers, or of 218,000,000 employee-days. To these disabling accidents must be added an untold, but very large, number of accidents that injure but do not disable, and others that do not injure but result in property damage. It is apparent that just in terms of sheer frequency of occurrence the accident problem is of utmost importance. Any procedure, therefore, by which accidents could be reduced even by a fraction of 1 per cent must necessarily be considered very valuable.

In view of the enormity of the situation, careful consideration must be given to the nature, causes, and conditions of accidents. This does not mean that the critical scientific analysis should be dropped and a popular survey analysis substituted in its place. Rather the reverse is true. It is unfortunate that in the area of accident study and analysis so many rule-of-thumb and unverified methods have been utilized. In desperation many things are considered truths that have not been subjected to scientific tests. Although perhaps no great harm is done, much good is left undone. Thinking must be clear, definitions exact, and conclusions based on sound fact, as in the study of any other behavior problem. In accident studies we must be doubly aware of the dangers inherent in inadequate data and in concepts based on opinion rather than on facts.

DEFINITION OF ACCIDENTS

Before factors related to accidents and their causes can be studied, it is necessary to count the number of accidents that occur under different kinds of conditions. Essential to such statistical analysis is an exact delineation of just what is to be counted. In other words the first step in accident analysis is the definition of what constitutes an accident. It will be seen that the definition of an accident is not easy to devise, and there will be marked variations in the meaning of the term from one situation to another.

Types of Definitions.—Lexicographically, an accident is an event that takes place without foresight or expectation and results in some type of personal injury and/or damage to equipment or property. However, such a definition is rather broad when used in connection with industrial accident analysis. The act of a saboteur in a plant fits this definition since, except to the saboteur, the act is not anticipated and does result in destruction. In such cases the injury or damage would not be considered to be the result of an industrial accident. In the transportation industry the throwing by a malicious child of a missile that causes damage to a vehicle is generally considered to be an accident. However, such an event really does not differ significantly from the act of an industrial saboteur. Similarly, unpredictable natural events such as heavy rains, landslides, and earthquakes will cause damages that are referred to as accidents.

A narrower definition of industrial accidents conceives them as resulting from faulty equipment or the inadequate performance of an individual, *i.e.*, something arising directly out of the work situation. In the cases cited previously, the damage is neither attributable to a faulty worker or to faulty equipment. When natural catastrophes are the agents that produce the events, there is clearly no connection with the job operations.

Since a large proportion of accidents result in some claim, either for personal injury or property damage, legal definitions also are utilized. A further interpretation can be found in the treatments of accidents in books on labor statistics. Here a mishap is identified as an accident only when a worker is injured.

From the foregoing statements it is apparent that there are several divergent viewpoints as to what constitutes an accident. Different criteria are used in different cases to determine whether the mishap is to be classified as an accident or not. Confusion arises because in the same analysis more than one criterion may be used, and no attempt is made to differentiate between the different criteria. The truth is that in most studies the investigator does not seem to be aware of the fact that he is using more than one criterion.

To be concrete, a given set of accidents may be classified or grouped in three different ways, viz., the nature of the event, the causes of the event, and the effects of the event. Generally the first or the last method of classification is employed, but, all too frequently, two or all three types of categories are used in the same analysis. Examples of these three ways of classifying accidents are given in Table 86. In many studies these different types of classification of accidents are not distinguished. Thus in a breakdown of accidents some will be tabulated in terms of the nature of the event, whereas others will be classified in terms of causes or in terms of effects.

TABLE 86.—EXAMPLES OF SYSTEMS FOR CLASSIFYING ACCIDENTS

Classification according to nature of the event (trolley-car and bus accidents)

- Traffic accidents
  - Collisions with pedestrians
  - Collisions with cars or buses
  - Collisions with motor vehicles
  - Collisions with fixed objects
  - Derail or switch occurrence without collision
- Passenger accidents
  - Boarding
    - Boarding moving car
    - Caught or struck by doors
    - Trips, slips, stumbles
  - Alighting
    - Alighting from moving car
    - Caught or struck by doors
    - Trips, slips, stumbles
- Occurrences on board
  - Thrown, fell, slipped
  - Miscellaneous

Classification according to cause of the event (machine-shop accidents)

- Accidents connected with machines
  - Catching of fingers, arms, clothing, etc., in machine
  - Catching of tools, guides, etc., in machines
  - Flying objects and particles
- Nonmachine accidents
  - Falling objects
  - Objects on floor
  - Pushes, bumps, etc., by other persons, trucks, etc.

TABLE 86.—(*Continued*)

Classification according to effects of the event (accidents in warehouse)

- Damage
  - To stored material
    - Complete loss of container and contents
    - Partial damage of container and contents
    - Partial damage of container only
  - To equipment
    - Hand trucks
    - Dollies
    - Conveyor
    - Crane
- Injury
  - Fatalities
  - Amputations
  - Foreign body in eye
  - Burns and scalds
  - Bruises, contusions, and abrasions
  - Cuts and lacerations
  - Fractures
  - Sprains and strains
  - Punctures

Need for Definition.—The point being made is that different accident statistics are not comparable unless the same base has been used in classifying the accidents. Comparisons of the hazardous nature of different jobs are made when the criterion used in classifying the accidents on one job is not the same as the criterion used on other jobs. Accidents in the transportation industry, where natural catastrophes play a part, are not comparable with accidents in clerical work, in which such catastrophes are never, or seldom, found. So long as investigators are unaware of this problem in classification and continue to compare accidents that are described in nonparallel categories, so long will the true picture of the determining factors operating in accidents be obscured.

ACCIDENT STATISTICS

One of the most difficult aspects of accident analysis is the formulation of adequate statistics. In order to ascertain which of two truck drivers is the safer operator, it clearly would be insufficient to compare them simply on the basis of number of accidents sustained. The accidents record for one driver might cover a much longer period than that for the other. Knowing only that one driver had two accidents and the other had four accidents is not sufficient information to compare them in terms of safety in operation. It would be some help to know that the first man had two accidents in 1 month and the second had four accidents in 3 months. Then it would be possible to equate the accident records of the two men on the basis of time and compute for each an *accident rate*. In this manner it would be seen that the accident rate of the first driver is two accidents per month and that of the second is 1.3 accidents per month. The latter now is seen to be the safer driver.

Types of Accident Rates.—Accident records for different individuals, conditions of work, kinds of equipment, etc., can be compared only when there is equal opportunity or exposure for all concerned. In the case of the two truck drivers we attempted to equate opportunity for having accidents statistically by reducing the accidents to a monthly basis. It might be more accurate, of course, to have ascertained the actual number of hours each man had driven and then compute a rate in terms of the number of hours of operation. Suppose, however, that one operator was so cautious that he drove at only half the speed of the other. Therefore, although his accident rate per *hour* of operation might be less, in terms of *distance traveled* or *work done*, it might be greater. It might well be questioned whether reducing accidents to equal times actually equates opportunity for having accidents. Equal opportunity, perhaps, should be conceived of as equal number or extent of operations, rather than equal time.

Variation in Results with Use of Different Types of Accident Rates. That these two methods of computing accident rates may make an important difference is illustrated in Table 87. In this table are given the basic accident data and the accident rates computed on the basis of

TABLE 87.—COMPARISON OF ACCIDENT RECORDS OF FOUR TYPES OF PUBLIC CONVEYANCES IN THE SAN FRANCISCO TRANSIT SYSTEM FOR ONE QUARTER

Type of conveyance	Accidents	Car hours operated	Car miles operated	Accidents per 10,000 hr. of operation		Accidents per 100,000 miles of operation	
				Actual number	Relative number	Actual number	Relative number
Motor coach.......	389	219,426	2,265,331	17.7	100	17.2	100
Trolley coach......	54	21,933	204,550	24.6	139	26.4	153
Trolley cars.......	2,189	558,660	4,923,643	39.2	221	44.5	259
Cable cars.........	157	20,122	117,328	78.0	441	133.8	778

hours of operation and on the basis of miles of operation, for four types of public conveyances in the city of San Francisco. Although the relative accident rates of trolley coaches and trolley cars, as compared with that of motor coaches, do not differ greatly when accident rate is computed on the basis of miles or hours of operation, the difference is very marked for cable cars. When hours of operation are used as a base, the accident rate of cable cars is seen to be something over four times as great as that of motor coaches, but, when miles of operation are used, the accident rate of the cable cars is found to be nearly eight times as great. The particular base used in computing accident rate will necessarily vary with the type of job being considered and the nature of the problem. However, in cases of doubt it would be appropriate to use both types of rates, since discrepant results might be obtained.

RESULTS OF ACCIDENTS

Costs.—Since accidents may involve damage to person, equipment, and property, they are expensive. In one transit system it was found that, taking into account all accidents whether major or minor, the average cost per accident in terms of claims paid was \$50. In one year this organization paid out more than half a million dollars in claims. These figures do not take into account money required for repairs to the organization's equipment. In addition to these direct costs there will be many hidden or indirect costs resulting from an accident. Heinrich has pointed out that, beyond claims paid and costs for repairs, there are further costs resulting from the lost time of the injured worker, lost time by supervisors and other workers who investigate and assist in the accident, etc.[2] In one case cited by this author, direct costs amounted to \$209, and indirect costs amounted to \$937; in another instance the accidents involved no direct costs, but indirect costs amounted to \$154.

Effects on the Individual.—It has been suggested that the individual who suffers an accident and recovers enjoys a certain amount of prestige among his fellows. However, if the accident is a relatively minor one, the fame acquired through "my accident" will probably not last any longer than the fame resulting from "my operation." If the individual persists in relating the events concerned with his accident, he undoubtedly will lose as much prestige as do those persons who insist on telling about their operation long after the scar has healed. On the other hand there is considerable clinical evidence indicating that if the accident is fairly severe the individual may develop rather marked personality disorders. He is apt to become apprehensive and irritable, neurotic symptoms may be induced, and delusions of persecution may develop to the extent that the individual may manifest vengeful reactions toward his employer or toward friends or members of his family.[3]

Social Consequences.—The social consequences of accidents are also worth considering. Besides the effects on the family, there are the many unpleasant experiences resulting from the recurring spells of despondency, often characteristic of the permanently disabled and occupationally unfit individual. Certainly the happiness, hopes, and sometimes even the health of the other members of the family are affected by the economic collapse that may result when the wage earner meets with a fatal or severe accident.

It is generally believed that the ordinary workman is well protected financially in the event of an accident. As Swan has pointed out, however, the extent of the protection is far from adequate.[4] At the present time in this country, all states but one require some sort of protection against occupational injuries or disease. Nevertheless the amounts of money received in the case of disability are generally insufficient to provide for the emergency, and in most instances individuals suffering from industrial hazards do not have sufficient income to build up a satisfactory reserve. It is to be remembered that monetary benefits to the injured worker can never compensate for his suffering nor protect him from the destructive effects of continued idleness.

INDIVIDUAL DIFFERENCES IN SUSCEPTIBILITY TO ACCIDENTS

Distribution of Accidents.—As with all types of measures of human performance, people differ with respect to the number of accidents that they incur in connection with their work. For the same period of time, some persons will not be involved in a single accident; *i.e.*, they will be accident-free, whereas others will be involved in many accidents. This fact of individual differences in accident rate has long been recognized. Distributions of accidents of the sort that are almost universally cited as being "typical" are shown in Table 88.[5] It will be noted from this table that the largest proportion of workers are accident-free, and that smaller and smaller numbers sustain one, two, three, etc. accidents, respectively. Since distributions of this kind, which are described as *J-shaped curves*, are the ones that are customarily reported, the belief has grown up that they are characteristic of all types of accidents.

The shape of the distribution of accidents among workers would be

TABLE 88.—DISTRIBUTIONS OF ACCIDENTS OF TWO GROUPS OF MACHINE OPERATIVES IN FACTORIES, ILLUSTRATING THE J-SHAPED TYPE OF CURVE

Men (647 cases, 1-month period)		Women (414 cases, 3-month period)	
Accidents	Workers, per cent	Accidents	Workers, per cent
0	69.2	0	71.6
1	20.2	1	17.9
2	6.5	2	6.2
3	3.3	3	1.9
4	0.5	4	1.0
5	0.3	5	1.0
		6	0.2
		7	0.0
		8	0.2
Total	100.0	. .	100.0

of little more than academic interest but for the fact that an important and not wholly valid conclusion is drawn from them. From the J-shaped curve it follows that most of the accidents are incurred by a very small proportion of the workers. In other words most of the accidents are attributable to a very few faulty individuals. From this situation some investigators conclude that elimination of this small number of persons would markedly reduce the total number of accidents. If the foregoing is assumed to be true, then the major emphasis in a safety program should be given to locating and separating the so-called "accident repeaters." For example, in one industrial plant employing several thousand workers it was found that 20 per cent of the workers accounted for all accidents, but 6 per cent accounted for 65 per cent of all accidents.[6] Presumably, therefore, elimination of this 6 per cent of men would reduce accidents by 65 per cent.

In generalizing from results such as these to all other situations where accidents occur, the following two assumptions must be made:

1. Provided there are no changes in methods and conditions of work, training procedures, and the like, the accident rate for each individual must remain the same from one period of time to another; *i.e.*, each worker's accident rate is constant.
2. The distribution curves of all types of accidents, for all jobs, are J-shaped.

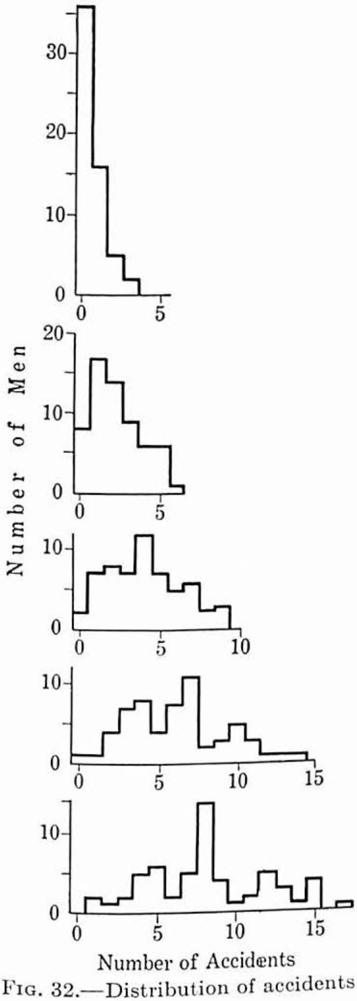
If the first proposition were not true, then, in a period of time after the elimination of the few high-accident individuals, others would move up to take their place. Furthermore, had these high-accident people been retained, their accident record might be considerably improved just in the natural course of events. Evidence pertinent to the constancy of accident rate will be examined in the next section. Suffice it to state here that accident rates are far from being constant; an individual's accident rate varies considerably from time to time, and the extent of this variation differs from one job to another.

Insofar as the second assumption is concerned, there are many instances, particularly in the transportation industry, where the distribution of accidents is definitely not J-shaped. Examples of distributions of this sort are given in Table 89, which can be compared with the distributions given in Table 88.[7] J-shaped curves may be expected to occur under two conditions: first, when the job is a relatively safe one and the average accident rate is low, and, secondly, when accident records are collected for only a very short period of time. The last condition is of course an artificial one. As longer and longer periods of time are used, the total number of accidents sustained by the group of workers increases because of increased opportunity to have accidents,

TABLE 89.—ILLUSTRATIVE DISTRIBUTIONS OF ACCIDENTS NOT OF THE J-SHAPED TYPE OF CURVE

100 Factory-machine operatives (5-month period)		142 Trolley-car motormen (1-year period)	
Accidents	Workers, per cent	Accidents	Workers, per cent
0	15.0	0	7.8
1	16.0	1	10.7
2	21.0	2	12.1
3	10.0	3	17.6
4	17.0	4	9.9
5	8.0	5	9.9
6	4.0	6	6.3
7	2.0	7	8.6
8	1.0	8	5.6
9	2.0	9	2.1
10	2.0	10	2.3
11	0.0	11	1.4
12	2.0	12	4.2
		13	0.0
		14	0.0
		15	0.7
		..	..
		22	0.7
Total..........	100.0	..	100.0

and the distribution of accidents departs more and more from the J-shaped curve. This is illustrated in Fig. 32, where the distributions of accidents for the same 59 trolley-car motormen are given for time periods of different lengths. It will be noted in this high-risk job that a small proportion of the workers account for a large proportion of the accidents and that for short periods of time, such as 1 month, the distribution of accidents fits the conventional J-shaped curve. With longer periods of time, however, neither of these conditions is true.



Length of period during which accidents were recorded	Total number of accidents incurred	Per cent of accidents caused by poorest 10 per cent of operators
1 month	32	50
4 months	92	39
7 months	242	18
10 months	366	20
13 months	485	19

FIG. 32.—Distribution of accidents of street-car motormen taken for various periods of time.

Consistency.—As pointed out in earlier chapters, the measure of consistency of performance is given by the reliability coefficient. With accidents, therefore, consistency in this type of performance can be measured by observing the degree of correlation between accident rates for a group of individuals for two periods of time. In Table 90 are given the reliability coefficients of accidents for several groups of workers. Experience indicates that, although the reliability of accidents frequently approaches zero, it hardly ever rises above 0.80. As compared with other measures of workers' performance, accident rate generally is much lower in consistency. Thus, although an individual's accident record shows some consistency over a period of time, the degree of consistency is not great, the accident rate of an individual showing a fair amount of fluctuation in the course of time. This means of course that the prediction of accidents is not an easy task.

TABLE 90.—RELIABILITY COEFFICIENTS OF ACCIDENTS FOR SEVERAL GROUPS OF WORKERS

Reliability	Cases	Job	Time
0.38, 0.44	524	Mechanic apprentices	Successive year periods[8]
0.39, 0.36	259	Mechanic apprentices	Successive year periods[8]
0.05, 0.27, 0.37	57	Dockyard apprentices	Successive year periods[8]
0.33, 0.25	100	Dockyard apprentices	Successive year periods[8]
0.57, 0.39, 0.37	94	Dockyard apprentices	Successive year periods[8]
0.72	21	Lathe operators	Two 3-month periods[9]
0.69	36	Lathe operators	Two 3-month periods[9]
0.37	22	Profiling operators	Two 3-month periods[9]
0.53	29	Profiling operators	Two 3-month periods[9]
0.29	34	Bus operators	8 months, odd and even months
0.44	59	Trolley-car motormen	8 months, odd and even months

Under present circumstances, it is impossible to account satisfactorily for the relatively low reliability of accidents. It may be that the tendency to have accidents is simply an unstable trait. On the other hand the simple process of recording and describing industrial accidents leaves something to be desired. Perhaps more careful definition of what constitutes an accident and a better description of the event might lead to measures yielding higher reliability.

THEORIES OF THE BASIS OF INDIVIDUAL DIFFERENCES IN SUSCEPTIBILITY TO ACCIDENTS

It has been noted that, with the same exposure to hazards on the job, workers differ with respect to the number of accidents in which they become involved. How can these differences be accounted for in terms of the susceptibility of the persons concerned? Four different theories have been advanced to account for individual differences in susceptibility to accidents. It is said that individual differences in accident rate are due (1) simply to chance, (2) to unequal and constant differences among individuals, (3) having once incurred an accident, to increased susceptibility to have further accidents, and (4), having once incurred an accident, to decreased susceptibility to have further accidents.

Chance.—According to the first theory, all persons are equally liable to suffer accidents, and it is simply a matter of luck to whom they occur. One person is just as likely as any other person to have a moment of carelessness resulting in an accident. This theory holds therefore that there is nothing within the individual or in his performance that characterizes him with respect to other individuals in terms of accident liability.

Unequal and Constant Differences in Susceptibility among Individuals.—This concept seeks to explain the distribution of accidents in terms of unequal liabilities. It is held that some individuals are more likely to be involved in accidents than are others, and that the degree of susceptibility to have accidents is distributed continuously along a continuum, like any other psychological trait. Each person is therefore characterized by a certain degree of susceptibility to have accidents. The degree of susceptibility may be small or large, but for a given individual it is constant. It is to be noted that this theory does not necessarily hold that an individual's susceptibility is the same for all hazardous situations. For one job an individual's likelihood of having accidents might be small, whereas for another job it might be large. This is not a crucial point for the theory but is simply a matter for investigation.

Increased Susceptibility.—This theory holds that at the beginning, on a given job, all persons are equally susceptible to accidents. The first accidents that happen are therefore determined purely by chance. However, those persons who suffer them are thereby predisposed to have more accidents. It is suggested that an accident may make the individual more apprehensive and nervous and less sure of himself, so that his later actions are not accurately controlled. Viteles has pointed out a parallel with certain diseases, such as tuberculosis, where the individual who has suffered from the disease is more liable to suffer from it on another occasion than a person who has never had it.[10]

Decreased Susceptibility.—Particularly in certain hazardous occupations it is sometimes said that the best way to avoid future accidents is to have one. This is the old notion that the burnt child never more plays with fire. Essentially this concept demands learning on the part of the worker, but, it is to be noted, the belief holds that learning to avoid accidents is not accomplished by simple experience on the job as such but by the experience of having an accident. That is, there is something in the experience of having an accident that cannot be gained by other means.

Evaluation of Various Theories.—In view of the vigor with which the proponents of these four theories advance them, it might be thought that each in itself is sufficient to explain all accidents. It is doubtful, however, whether even the archproponents of any one theory would consider it completely satisfactory. Indeed the results of studies of accidents indicate that no one theory can suffice as the sole explanation of individual differences in accident rate.

If accidents were due solely to chance, then no correlation between accident rate on two successive periods should be found. As we have seen, the evidence indicates that there is some consistency in accident performance from one time to another. This means, therefore, that to some degree, systematic factors within the individual are operating in determining his performance in such situations.

If the accidents sustained by workers were due solely to unequal and constant differences in susceptibility among them, then the coefficient of correlation between accidents on two successive periods should be practically perfect. Evidence has been presented to show that such coefficients are greater than zero, but that they are by no means perfect. Clearly, factors other than individual differences in susceptibility to have accidents are operating to cause them.

From the concept of increased susceptibility, it follows that the accident rate of a group of workers who have had accidents should increase at a faster rate than that of an accident-free group. Such does not appear to be the case. Rather, if for a given interval of time workers are divided into a group who incur accidents and another group who do not, the accident rate of the former group decreases while that of the latter increases. Greenwood and Woods, for example, divided women employees in a munitions plant into two such groups on the basis of accident records for 1 month and found that, in the 5 following months, the average number of accidents of the accident group decreased from 1.31 to 0.41, whereas those of the accident-free group rose from 0.00 to 0.15.[11]

The concept of decreased susceptibility following the experience of an accident, as an explanation of all accidents, is disproved primarily by certain clinical evidence.[12] There are some workers who appear to be continually involved in accidents and still are not cognizant that the accidents are due to error on their part. They gain nothing from their experience and believe that their accidents are due to chance or to the faults of other individuals.

Although no one of these four theories may be considered as describing the all-important determiners of accidents, each obviously explains some of the causes. The many psychological studies of attention have proved the impossibility of continuous concentration on any item over long periods of time. Therefore moments of abstraction and carelessness may be expected, and chance factors cannot be ruled out as a cause of accidents. Since the accident rate of a group of workers does show some consistency from one period to another, the fact of unequal and constant differences in susceptibility among individuals must be accepted. Studies of individual cases indicate that in some instances the traumatic experience of previous accidents does render the person more apprehensive and nervous, and therefore more likely to be involved in further accidents.[13] Finally, some individuals do learn to avoid accidents after having them, the heightened emotional situation impressing upon them facts relative to safe operation, of which they might not have otherwise become cognizant.

Using these four major factors in accidents as a framework, a plan for accident prevention can be outlined. The occurrence of chance moments of carelessness suggests that it would be profitable to discover the conditions under which these moments are most likely to occur, so that these conditions can be avoided. The fact of individual differences in susceptibility to accidents suggests that discovery of the psychological characteristics associated with such susceptibility would be useful for both corrective and selective purposes. The effect of increased susceptibility to accidents indicates the need for an individual, clinical study of the worker involved in repeated accidents. And finally the effect of decreased susceptibility indicates not only the importance of training in safety but also that such training should be forcible and of such a nature as to be personally meaningful for each worker.

ACCIDENT PRONENESS

By accident proneness is meant the tendency of persons to retain their relative liability to be involved in accidents. Evidence in the form of correlations between accident rate in two successive time intervals affords validity for this concept. Certain writers have defined accident proneness as a retention of liability under all circumstances.[14] The correlations just referred to are evidence of the consistency of individual differences in a specific working situation, but they give no indication of a consistency to be found generally in all situations where accidents occur. What is needed, therefore, is information concerning the degree of relationship between different types of accidents.

Newbold studied the relationship between two types of accidents incurred by groups of factory workers, and their relationships to accidents that occurred at home. The coefficients of correlation obtained were of the order of 0.20 to 0.30.[15] For bus drivers the present authors found a coefficient of correlation between collision and noncollision accidents of 0.25 for one group and of 0.13 for another. For trolley-car motormen, the coefficient was found to be 0.09. These correlations are fairly low and indicate little generality for proneness to have accidents of different kinds and in different situations.

THE PREDICTION OF INDIVIDUAL LIABILITY TO ACCIDENTS BY PSYCHOLOGICAL TESTS

While investigators concerned with industrial safety problems have long emphasized the importance of the selection of workers in terms of liability to have accidents, there have been surprisingly few systematic investigations of the usefulness of psychological tests in the selection of safe workers. For one thing, in most industrial organizations, problems of personnel and problems of safety are handled by departments having little or no connection. The personnel department, which is closely tied to operations and production, has tended to evaluate selection devices in terms of the degree to which they predict output rather than safe operation. Thus in most instances the safety department because of organizational structure is prevented from stating its case when new employees are being selected.

A second factor of importance is the lack of adequate accident records. In general most industrial accident records are either incomplete or in such a form that it is impossible to ascribe the accident to the worker concerned or to other persons or agencies. Under the circumstances it is not surprising to find that most of the studies on the use of tests in the prediction of accidents have been made in the transportation industry, where accidents are of prime importance, both from the point of view of costs and of smooth operation.

Industrial Operations.—Results obtained by Farmer and Chambers, from the application of a variety of tests to three groups of young apprentices, are given in Table 91.[16] It is apparent that no one test gives satisfactory results. A weighted combination of the more valid tests, however, gave a satisfactory correlation with accidents, a coefficient of the order of 0.45. Certain of these tests were administered to other groups of workers with slightly better results.[17] These coefficients are given in Table 92. Again, although the individual tests gave unsatisfactory results, weighted combinations of them predicted accidents to a reasonably acceptable degree.

TABLE 91.—VALIDITY OF VARIOUS TESTS FOR THE PREDICTION OF ACCIDENTS OF APPRENTICES IN THREE OCCUPATIONS

Tests	Carpenters' apprentices	Fitters' apprentices	Dockyard apprentices
Reaction time	−0.01	−0.05	0.11
Dotting	−0.01	0.06	0.17
Pursuit meter	0.19	0.03	0.22
Pursuit with distraction tasks	−0.01	0.00	−0.03
Bimanual coordination	−0.09	0.07	−0.13
Spatial relations:			
Forming rectangles	−0.04	−0.03	
Judgment of length	−0.03	0.00	
Building cubes	−0.01	−0.08	
Number setting	−0.06	−0.01	0.10
Binocular vision	−0.13	0.14	
Strength of grip	−0.09	−0.12	0.01
Intelligence	−0.01	−0.08	0.13

TABLE 92.—VALIDITY OF VARIOUS TESTS FOR THE PREDICTION OF ACCIDENTS OF WORKERS IN SEVERAL DIFFERENT OCCUPATIONS

Test	Shipwrights	Electrical fitters	Engine fitters	Naval artificers I	Naval artificers II
Reaction time	0.20	−0.07	−0.16		
Dotting	0.25	0.13	−0.06	−0.08	0.14
Pursuit	0.18	0.16	0.16		
Number setting	0.27	−0.15	−0.10		
Intelligence	0.12	−0.01	0.31	0.09	−0.03

Schaefer has offered results on 6,829 industrial workers relative to the relationship between their intelligence test scores and their accident rate.[18] His results are shown in Table 93. For these workers there is obviously a positive relationship between test score and accidents. The variation in accident rate for workers at any given score level is not indicated, however, and therefore the magnitude of the relationship between scores and accidents cannot be estimated.

TABLE 93.—THE RELATIONSHIP BETWEEN INTELLIGENCE TEST SCORES OF INDUSTRIAL WORKERS AND ACCIDENT RATE

Intelligence Test Score	Accidents per Year per 100 Workers
(High) A	0.66
B	1.12
C	1.53
D	2.08
(Low) E	2.76

Transportation Industry.—In the transit industry the first major contribution made in this country was by Viteles.[19] He devised a multiple stimulus-reaction test, involving the presentation of various stimuli to which different types of coordinated responses were made. For a group of motormen, a coefficient of correlation of the order of 0.40 was obtained between scores on this test and supervisors' ratings of safety. On the other hand, two intelligence tests were found to be unrelated to this criterion of safe operation. A further check on the validity of Viteles' multiple stimulus-reaction test was made by Shellow, in which test scores were compared with actual accident records. Although still showing the test to be useful, the findings indicated a somewhat lower validity.[20] Slocombe and Brakeman employed a test for streetcar motormen that involved accuracy and speed of movement.[21] Again, although this test showed validity, it was not particularly high. They studied 92 operators, 54 per cent of whom were considered low-accident men. The proportions of low-, medium-, and high-scoring men found in this group of low-accident cases were as follows:

	Per Cent
Low scorers	56
Medium scorers	53
High scorers	50

The present authors, in studying a group of trolley and motor coach operators, found a coefficient of correlation of only 0.05 between intelligence test scores and accidents. Ghiselli, Brown, and Minium administered a variety of tests to 153 motormen and compared the scores with accident records for an 8-month period.[22] The results of these investigators are shown in Table 94. Their findings indicate that measures of speed and accuracy of movement, judgment of distance, and knowledge of mechanical functions have reasonably good validity. Tests of visual function, on the other hand, with the probable exception of distance judgment, were found to have no value.

The National Safety Council has reported results on a series of tests administered to 180 motor-coach operators.[23] On each test a "passing" score was set as the average score made by operators who had fewer than the average number of accidents. The results, given in Table 95, suggest that certain types of simple motor tests may have some validity. The stability test, involving bodily sway in the standing position, and muscular reaction, involving measures of balance, coordination, relaxation, and tremor, show a positive, though low, relationship with accident rate. Reaction time also is related to accident rate, the quick reactors having the higher rate. The visual tests, on the other hand, show practically no relationship with safety of operation. In this connection it is interesting to note that Wechsler, in studying taxicab drivers and employing a test involving various

TABLE 94.—RELATIONSHIP BETWEEN SCORES ON VARIOUS TESTS AND INCIDENCE OF ACCIDENTS OF STREETCAR MOTORMEN

Tests	Making fewer than average number of accidents, per cent	
	Men earning good scores	Men earning poor scores
Paper-and-pencil tests:		
Tapping	63	38
Dotting	56	41
Mechanical principles	55	44
Judgment of distance by perspective	56	44
Judgment of linear distances	54	46
Visual tests:		
Acuity	51	49
Field of vision	51	48
Glare recovery	48	49
Distance judgment	55	45
Performance tests:		
Foot reaction time	58	42
Steadiness	50	50

responses to a series of stimuli, found that both very quick and very slow responses were associated with poor accident records.[24] The number of errors made on the Wechsler test was positively correlated with accidents.

TABLE 95.—THE RELATIONSHIP BETWEEN SCORES ON SEVERAL SIMPLE TESTS AND FREQUENCY OF ACCIDENTS OF MOTOR-COACH OPERATORS

Accidents in 9-month period	Bodily stability	Operators "passing" test, per cent				
		Simple reaction time	Muscular reaction	Depth perception	Field of vision	
					Right eye	Left eye
0–1	71	57	100	86	72	86
2–3	90	70	90	80	100	100
4–7	65	72	83	87	85	84
8–9	48	86	76	76	90	86
10–12	55	86	91	82	59	77
13–17	45	89	66	89	78	89

Evaluation of Selection Tests with Respect to Accidents.—The foregoing review relative to the usefulness of tests in the prediction of accidents, although not exhaustive nevertheless presents typical findings. It is apparent that weighted combinations of tests may give reasonably good results, yet there are no particular types of tests that are uniformly outstanding. The generally low validity coefficients of psychological tests in the prediction of accidents has been somewhat disappointing. Before it is finally concluded that test prediction is inadequate, however, the nature of the characteristic being predicted should be more closely examined. It may well be that the fault does not lie in the test but rather in the criterion of performance, viz., reported accidents, with which the tests are being correlated.

It was noted in a previous section that the reliability of accidents, as they are recorded in the industrial situation, ordinarily is not high. This means that such accidents are not particularly good predictors of themselves. Under the circumstances, therefore, it can hardly be expected that behavior of another sort, *i.e.*, performance on a test, can give a wholly satisfactory prediction. When considered in the light of the reliability of accidents, the predictive effectiveness of tests appears considerably better than judged at first glance.

It is likely that if the index of accident proneness could be made more reliable the predictive effectiveness of tests automatically would be increased. Means of doing this have been previously considered. If only those accidents were considered that were due solely to faulty performance on the part of the worker, then perhaps prediction would be facilitated.

It has been suggested that, even under the best of circumstances, tests cannot adequately measure the basic psychological tendencies involved in accident proneness. The notion is that safety in operation is best achieved by means other than preselection of workers in terms of their liability to have accidents. There is some evidence, however, which strongly indicates that this notion is invalid. During the last war, the U.S. Army Air Forces employed an extensive battery of tests for the selection and classification of aircrew.[25] Although these tests were designed to predict proficiency, it was found that they also predicted accidents.

The pertinent case for the present discussion concerns the relationship found between the test scores and accidents of some 1,500 pilots, who had been tested a year or more before the period when accident records were kept. All the pilots involved were experienced personnel. Although the relationship between test scores and accidents was fairly low, being of the order of 0.15, it seems that the tests measured some basic tendencies in accident proneness, since it was found that severity of accidents also was related to test scores. Thus pilots involved in fatal accidents had lower test scores than those involved in nonfatal accidents, and pilots involved in accidents resulting in severe damage to equipment had lower scores than those involved in accidents in which there was little or no damage.

THE INFLUENCE OF WORKING CONDITIONS

Temperature.—In a study of the relationship between temperature of the work environment and frequency of minor accidents, Osborne and Vernon found for groups of factory workers that accident rate was at a minimum during the more moderate temperatures.[26] Their results, given in Fig. 33, show that as temperature was either increased or decreased from moderate temperatures, accident rate increased.

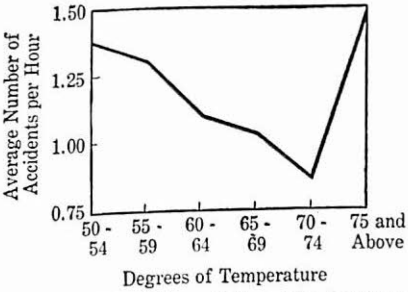


FIG. 33.—The relationship between temperature in the workshop and accidents of factory workers.

These findings are typical in that they point to an optimal temperature at which accidents are at a minimum, and that with either warmer or colder atmospheres accidents occur with greater frequency.[27] There is some indication that, with extreme temperatures, not only is accident rate increased, but also the severity of accidents is greater.[28] Thus, when a worker suffers an accident under conditions of higher temperatures, the accident is likely to be of a severity that will cause him to be off the job for a longer period of time than with an accident incurred under more moderate atmospheric conditions.

It is of interest to note that the effects of extreme temperatures are more marked with older than with younger workers.[29] Under conditions of very high temperatures the accident rate of the older workers is much higher than that of the younger ones, whereas with more moderate temperatures the differences between the older and younger workers are less significant.

Illumination.—As might be expected, accident rate shows an increase under conditions of poor illumination. In one survey of a variety of different occupations it was found that, under conditions of inadequate artificial lighting, accident rate was 25 per cent greater than under ordinary daylight illumination.[30] Under inadequate illumination certain types of accidents show a greater increase than other types. In the survey just mentioned it was found that under poorer conditions of illumination there was a greater increase in accidents due to workers falling than in those due to either machinery or falling bodies. It has been noted in factories that, at the onset of darkness toward the end of the working day before the plants are completely lighted by means of artificial illumination, the incidence of accidents shows an increase.[31]

Day Shift versus Night Shift.—Allied to the problem of illumination is that of the effects of night work upon accidents. Vernon has noted that in four different munitions plants the accident rate among workers on the night shift was 17 per cent less than that among workers on the day shift.[32] The evidence indicates that, in part at least, this superiority of the night shift is due to the more effective illumination provided by artificial means than that afforded by natural means during the day shift.

In Table 96 are shown certain results obtained by Vernon relative to the frequency of accidents on the night shift, in relation to adequacy of artificial illumination, when these accidents are compared with frequency of accidents on the day shift.[33] It is obvious that on the night shift accidents are relatively more frequent under poorer conditions of artificial illumination than under conditions of good illumination. The table also shows that with eye accidents, as compared with other types of accidents, the night shift stands in a relatively poorer position. It is apparent therefore that, under conditions of adequate illumination, accident rate on the night shift is likely to be less than that on the day shift. Furthermore the relative superiority of the night shift will be less with certain types of accidents than with others.

Table 96.—Accident Rate of Factory Workers on the Night Shift in Relation to Adequacy of Illumination and Compared with Accident Rate of Day-shift Workers
(Day-shift Accident Rate: 100)

Type of factory operation	Condition of lighting	All accidents	Eye accidents
6-in. shells	Good	80	94
9.2-in. shells	Good	81	99
9.2- and 15-in. shells	Moderately good	81	103
Fuses	Fairly good	90	141

FATIGUE AND WORK

Fatigue.—As we have seen, the concept of fatigue is not at all a clear one. The term fatigue does not describe a single state of the individual but rather covers several different states that may vary somewhat independently. Thus at a given time the individual might be considered to be fatigued in one sense but not fatigued in another. Any explanation of the performance of industrial workers in terms of fatigue will therefore be somewhat unsatisfactory.

Circular reasoning with regard to fatigue is particularly evident when fatigue is offered as a cause of accidents. If a single instance is found in which fatigue is present, it is used as positive proof for fatigue causing accidents, but those cases in which contrary results are found are not considered as negative evidence, *i.e.*, as denying that fatigue causes accidents. In the latter cases it is argued that fatigue was not operating. Suppose that in one factory it is found that accidents increase toward the end of the working day. It is then argued that this is evidence that the fatigued worker is more likely to have accidents. On the other hand, if there is no increase in accidents during the day, it is said that the work was simply not fatiguing, and if accidents actually decrease throughout the day the explanation is offered that totally different factors, such as reduced opportunity to have accidents, are at work.

It is to be noted, however, that these three sets of findings can just as easily be used as evidence that fatigue does not produce an increase in accidents. The last two facts could be used as evidence that the fatigued worker does not have a heightened accident rate, and the first fact, that accidents increase toward the end of the day, could be explained away by saying that it is due to factors other than fatigue.

It does not appear advantageous, therefore, to consider accidents in relation to such a nebulous concept as fatigue. It will be more fruitful to consider the nature and conditions of work as they might affect accident rate. In the following discussion we shall consider diurnal variations in accidents, speed of work, severity of work, and length of the work period, in relation to accidents.

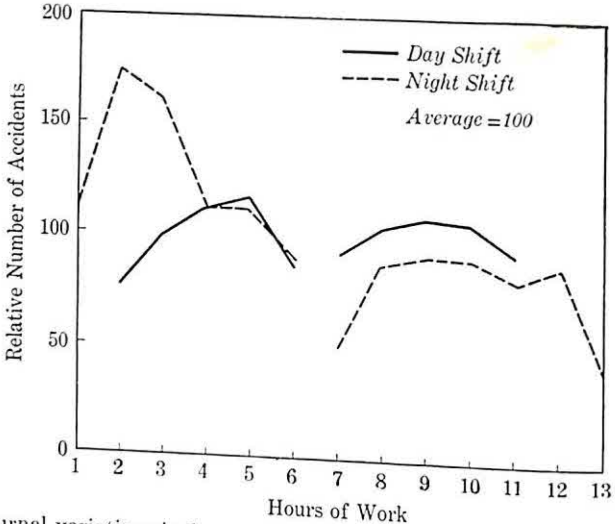


FIG. 34.—Diurnal variations in frequency of occurrence of accidents of factory workers on the day shift and on the night shift.

Diurnal Variations.—In Fig. 34 is shown the frequency of accidents in a factory in relation to daily hours of work, both for the day shift and the night shift.[34] These curves appear to be fairly typical for industrial work.[35] The frequency of accidents in both the morning and afternoon periods gradually increases and then decreases toward the end of the working spell. With day-shift workers the frequency of accidents in the morning does not appear to be significantly different from that in the afternoon. For the night shift, accidents generally are considerably higher in the first working spell than in the second. It is to be understood of course that the shape of these diurnal curves varies with the nature and conditions of work.

Speed of Work.—If the daily curves of production are recalled, it will be noted that they are similar in shape to those of accidents. This has given rise to the suggestion that industrial accidents are a function of speed of production; *i.e.*, during those hours when the worker operates at a slower rate the frequency of accidents will be less than when he operates at higher speeds.[36] If this were true, then the number of accidents per unit of output should be constant throughout the day.

The concept of speed of work being a major determiner of accidents has led to considerable controversy. Osborne and Vernon found that for different groups of factory workers on the day shift the ratio of accidents to output was relatively constant with the exception of the final hours of work, when it was somewhat reduced.[37] For similar workers on the night shift, however, the ratio of accidents to production was found to decrease gradually. Illustrative findings of these investigators are given in Fig. 35. On the other hand, results obtained by Goldmark, Hopkins, and Florence, shown in Fig. 36, indicate a rise in the number of accidents per unit of production from the beginning to the end of the working day.[38] Since the results of studies concerning the relation of the speed of work at different intervals of the working day and accident rate are not in agreement, no final conclusion can be drawn from them.

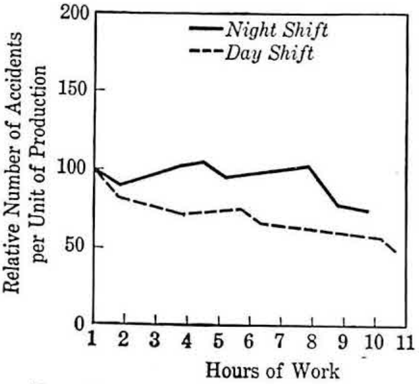


FIG. 35.—Relative number of accidents per unit of production of day-shift and night-shift factory workers in relation to daily hours of work.

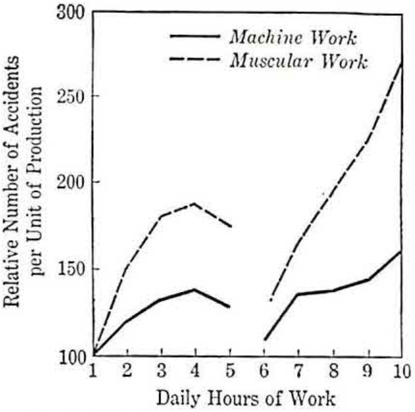


FIG. 36.—Relative number of accidents per unit of production of physically demanding (muscular) factory work and less demanding (machine) work in relation to daily hours of work.

At first thought one might expect that the frequency of accidents might vary directly with the speed of work. This expectation has two different bases. First, when the individual is working faster he has increased opportunity to have accidents, and, secondly, under conditions of increased speed of work he is not able to exercise the care that he can when working slower. Critical examination of these two points will throw some doubt upon the basic conceptions.

The first proposition hinges directly on the nature of the work. If the hazards that lead to accidents arise directly out of the industrial operation itself and if they have no connection with surrounding conditions or other aspects of the process, then it would be true that each unit of work would provide the same opportunity to have accidents. Only when an individual is operating his equipment could he have an accident. When an individual is working faster, it simply means that the pauses between machine operations become shorter, and during these periods he cannot have accidents. In a working situation such as this, one would have to accept the argument that accidents are a function of speed of work. With other kinds of jobs the hazards might not arise from the individual's work but rather from surrounding activities. In this case, speed of production would not be highly related to accident rate. Obviously most industrial work hazards will arise from both the work itself and from surrounding activities. The degree to which accidents will be a function of speed of work will therefore be determined by the nature of the situation.

The second argument is rather tenuous, owing to the lack of pertinent data. It is clear that with excessive speeds of operation the individual will not have opportunity to foresee and avoid events leading to accidents. For example, persons who drive cars at high rates of speed have more accidents than those who drive at slower speeds.[39] Experiments in the psychological laboratory on quality of performance show speed of work to be an important factor.[40] Increasing the speed of work produces a disproportionately greater increase in error. In other words, as speed of work is increased from very slow to very high speeds, there will be no great change in errors at first and then they will begin to increase markedly.

The pertinent question to ask is: just what range of speeds is under consideration? Certainly it would seem likely that in situations where the worker must continue on his job for long periods, operations cannot proceed at excessive speeds, *i.e.*, at a rate to be found in the area of the curve where errors begin to mount significantly. Since there are no data describing the speeds of industrial tasks, and since the critical speeds doubtlessly will vary from one task to another, no satisfactory answer can be given to this question.

This conclusion does not mean that the ratio of accidents to production is a meaningless figure. Rather, as was indicated in the earlier discussion of accidents, amount of work constitutes a useful base for comparing accidents occurring under different circumstances. In the following discussion it will be shown that it is a useful means of evaluating different accident conditions.

Severity of Work.—By severity of work is meant the extent to which the operations make physical demands upon the worker. Some jobs, such as the clerical occupations, require far less physical effort in their performance than others, such as the jobs performed by longshoremen. In terms of the mental effort demanded by the work, of course, the picture may be very different. Although there is no wholly satisfactory index of the physical demands of jobs, rough groupings at least are possible.

The evidence concerning accidents in relation to severity of work is not so complete as might be desired. It does appear at least by some indices, that physically demanding work is less safe than less demanding work. It is impossible to compare directly the accidents incurred in the two types of work, since the nature of the work will be different. No great differences were found when comparing the frequency of accidents in the afternoon spell with that in the morning for more and for less physically demanding jobs. Goldmark, Hopkins, and Florence found that for factory workers engaged in muscular work the ratio of afternoon to morning accidents was not significantly different from that for persons engaged in machine or handwork.[41] The afternoon productivity of the men engaged in the heavier work, however, was relatively less than that for the men engaged in the lighter work. In terms of accidents per unit of production, therefore, the workers on the more demanding jobs appeared to be at a disadvantage. The diurnal curves for two of these groups, in terms of accidents per unit of work, are given in Fig. 36. It will be noted that, as the working day proceeds, the number of accidents per unit of production shows a significantly greater increase for men in jobs requiring more physical effort.

Length of the Work Period.—It is generally presumed that increasing the length of the working period will result in a disproportionate increase in accident rate. The results do not bear out such a notion. To be sure, with longer periods of work, the individual has greater opportunity to have accidents in terms of time, but if his rate of work is slower, the number of accidents per unit of work may not show any increase.

Osborne and Vernon found that for groups of factory workers a reduction of the length of the work period did reduce accidents.[42] For a group of workers on the day shift, reduction of the working week from 59 to 35¼ hr.—a reduction in working time of 40 per cent—brought about a reduction in accidents of 10 per cent. For night-shift workers, reduction of the weekly hours from 63 to 48 hr.—a reduction of 24 per cent—brought about a reduction in accidents of 25 per cent. It is apparent from these findings that with industrial workers the frequency of accidents is related to the length of the work period, but the particular nature of the relationship is not clear.

Somewhat more illuminating results obtained by Vernon are given in Table 97.[43] Here frequency of accidents is related to length of work period and speed of work. For the industrial workers represented in this investigation it can be seen that lengthening the work period produces an increase in frequency of accidents roughly proportional to the increase in time. Thus longer periods of time might be considered less safe than shorter periods. However, with longer periods of work, speed is decreased. Thus, when number of accidents is related to units of work turned out, it appears that longer periods of time are not less safe than shorter periods but rather appear to be less hazardous.

TABLE 97.—ACCIDENTS OF FACTORY WORKERS IN RELATION TO LENGTH OF THE WORK PERIOD AND SPEED OF WORK

Hours of work per week	Relative hours of work	Relative number of accidents per week	Relative speed of production per hour	Relative number of accidents per unit of production
Men				
44.9	100	100	100	100
46.8	104	106	98	82
51.8	115	114	92	69
Women				
48.0	100	100	100	100
51.4	107	111	88	99

The nature of this association quite naturally varies with the nature and conditions of work. Obviously, with production-line operatives and others whose speed of work is set by machines and schedules, this association between hours of work and accident rate will be different. But even in such cases it has yet to be shown that longer hours produce a disproportionate increase in accidents.

PERSONAL FACTORS IN ACCIDENTS

Experience.—Many reports have been published that presumably show a relationship between experience and accidents.[44] In general these findings indicate that, with increasing experience, accident rate shows an initial rapid decrease followed by a more gradual reduction. Typical results of investigations of this kind are given for trolley-car motormen in Fig. 37.[45] All these studies suffer from an important error insofar as the assessment of experience is concerned. The procedure in these investigations is to divide men in a given organization into experience groups and then calculate the accident rate of each group.

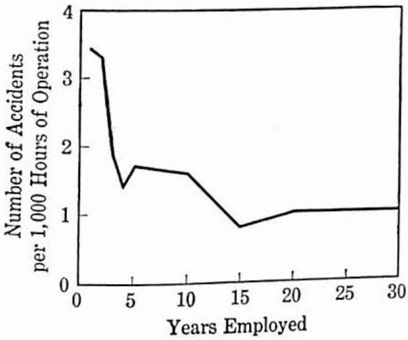


FIG. 37.—Accident rate of streetcar motormen in relation to years of experience on the job.

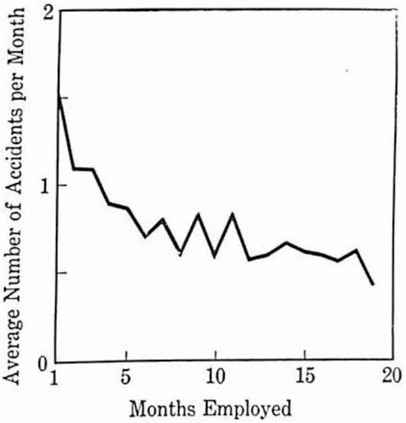


FIG. 38.—Relationship between months of experience of trolley-car motormen and accident rate.

This method must necessarily assume that, if there were no differences in experience, all these different groups of men would have the same average number of accidents. It is obvious, however, that in many jobs high-accident men will be either retired through injury or separated or will leave the employment voluntarily. This means that those persons who stay on the job for longer periods of time will be selected in terms of safety in operations. The drop in accidents with increased time on the job may be due, in part or in whole, simply to a dropping of the high-accident operators. At any rate, with such data the effects of experience and selectivity will be so intimately related that the effects of the one cannot be distinguished from the effects of the other.

What is necessary in order to evaluate the effects of experience is to follow the accident history of the same group of workers over a period of time. In this manner the effects of selective elimination of individuals will be avoided. In Fig. 38 are shown the accident rates per month of a group of trolley-car motormen for the first 19 months of their employment. By the end of the fifth month on the job, their accident rate was halved, and by the end of the nineteenth month, it was reduced to about one-third. A relationship between accidents and experience is thus demonstrated. Similar results for factory workers are cited by Chaney and Hanna.[46]

To evaluate the effects of experience over a period of years would be more difficult. Conditions and methods of work, together with type of equipment, are likely to change, thus rendering accidents in one period not comparable with those in another period.

Age.—The picture with regard to age as a factor in accidents is similar to that for experience. In typical investigations of the relationship between age and accidents, workers are simply divided into age groups, and the accident rate for each group is computed. In almost all instances, age is highly correlated with experience, and therefore any relationship obtained with accidents cannot definitely be ascribed either to age or to experience. In most instances the results show that accident rate decreases with increasing age, although this relationship is by no means universal.

Certain attempts have been made to hold experience constant by statistical devices. In one such investigation Newbold showed that, when experience of factory workers was held constant by means of partial correlation procedures, the relationship between age and accidents was reasonably high and negative.[47] Such relationships, however, do not hold for all jobs. Brown, Ghiselli, and Minium found for streetcar motormen that when experience was held constant in this manner the relationship between accidents and age was practically zero.[48] It is not at all certain that the holding of experience constant by the use of partial correlation methods or allied procedures is wholly adequate, in view of the fact already mentioned that the more experienced groups of workers are likely to be selected in terms of the safety of their performance. It is very probable that the selective factors operating in these cases prevent compliance with the basic assumptions inherent in the statistical method.

One thing that does seem clear is that, when an older worker suffers an accident, the consequences are likely to be more severe than they would be for a younger worker. Vernon, Bedford, and Warner found that when older coal miners suffered an accident it was likely to keep them off of the job for longer periods of time.[49] An example of their findings is given in Table 98. Similarly in the steel and iron industry, Hanna and Chaney found that the accidents suffered by older workers were more likely to result in death or permanent disability.[50] The results of these investigations are given in Table 99.

TABLE 98.—THE RELATIONSHIP BETWEEN AGE AND SEVERITY OF ACCIDENTS AMONG COAL MINERS

Length of absence, days	Age			
	Under 30 years	30 to 39 years	40 to 49 years	50 years or more
	Per cent			
Under 20	67	65	56	48
20–59	28	28	35	41
60 and more	5	7	9	11

TABLE 99.—PROPORTION OF ACCIDENTS AMONG WORKERS IN THE IRON AND STEEL INDUSTRY THAT ARE FATAL OR RESULT IN PERMANENT DISABILITY IN RELATION TO AGE

Age	Steel mill, per cent	Tube mill, per cent
Under 20	1.5	
20–29	1.8	1.6
30–39	1.7	1.6
40 and over	2.5	2.8

Health and Physical Defects.—As might be expected, not only is general health related to proneness to have accidents, but also physical defects of various sorts predispose the individual to increased accident liability. In a study of nearly fifteen thousand trades and dockyard apprentices, Farmer and Chambers found a correlation of the order of 0.30 between accident rate and number of illnesses.[51] A relationship of about the same degree was obtained by Newbold for workers in various manufacturing industries.[52] Viteles compared the accident rate of electrical substation operators suffering from physical defects with that of operators without such defects and found that the number of accidents of the first group was three times as high as that of the latter.[53] Slocombe and Bingham, in a study of streetcar operators over fifty years of age, found that the accident rate of men with abnormal blood pressure was more than twice as high as that of men with normal blood pressure.[54] Among industrial workers, Tiffen has compared the accident rate of workers who failed various visual tests with that of workers who passed such tests.[55] His results, given in Table 100, show that deficiencies in acuity, distance perception, and phoria (distance vision) are associated only to a small extent with accidents.

TABLE 100.—ACCIDENTS OF INDUSTRIAL WORKERS IN RELATION TO THEIR PERFORMANCE ON VISUAL TESTS

Test	Per cent having lost-time accidents	
	Passing test	Failing test
Acuity, far	1.09	1.37
Depth perception	1.23	1.57
Color vision	1.21	1.14
Phoria	1.26	1.82

Since similar results have been found (Tables 93 and 94) in the transportation industry, it is apparent that visual skills do not seem to be important factors in accident causation.

The foregoing evidence should not be interpreted as meaning that the physically handicapped individual has no place in industry. In the first place, the worker is unaware of his deficiencies in many instances, and is therefore unable to compensate for them. When he becomes cognizant of them and is instructed in compensatory procedures, the situation can be made more favorable. Secondly, employers do not always realize the importance of physical limitations and fail to place workers in suitable jobs. With an accurate program of placement, in which the physical demands of the job are accurately known and are compared with the physical limitations of the worker, accidents can be minimized. Hanman compared the accident rate of a group of physically handicapped mechanical and manual workers in a Navy depot with that of a group of able-bodied workers.[56] He found that with adequate placement of the physically limited individuals their accident rate was even less than that of the able-bodied workers.

Mental and Emotional Factors.—It is common observation, supported by an abundance of evidence, that the mental and emotional state of the individual is an important factor in accidents. Hersey, in a comparison of the mood of industrial workers with their accidents, found that 50 per cent of their accidents occurred during the period when they were emotionally depressed, such periods of depression comprising only about 20 per cent of their working time.[57] In a study of streetcar motormen it was found that in one-fifth of the accidents personality maladjustment or improper mental attitude was the primary factor.[58]

The importance of such findings is not to be minimized, since they do point to the role played by mental factors; nevertheless it should be noted that the types of behavior referred to are symptoms of psychological disturbance rather than psychological determiners of accidents. In order to understand the mental factors in accidents thoroughly, it is necessary to give our attention to the emotional forces resulting in unsafe performance rather than content ourselves with describing behavior that is associated with such performance. It is of little help, for example, to offer uncooperative behavior, inattention, and poor attitude as explanations of the causes of accidents. Only in a superficial sense are these factors productive of accidents. What we need is some understanding of the factors that produce not only uncooperative behavior, inattention, and poor attitude but also accidents. These unsatisfactory ways of behaving may have very different bases in different individuals. One individual may not have the so-called "safety attitude" because he has had trouble with his superior and, at the moment, does not like his job or anything connected with it. Another worker may be similarly described because he is unable to concentrate on his job due to financial or home worries. The situation cannot be corrected by emphasizing a change in attitude. The mental and emotional factors underlying the poor attitude and at the same time conditioning the individual toward unsafe behavior must be uncovered.[59]

From the foregoing discussion it is not to be implied that mental and emotional factors are considered as if they were the direct implementing factors in accidents. Such a notion would not be true except, perhaps, in cases of sabotage or as manifestations of sadistic or suicidal tendencies. Mental and emotional factors should be considered in the light of predisposing conditions likely to lead to accidents. The individual who is emotionally disturbed will not necessarily have more accidents than a well-adjusted person; rather, he is *more likely* to have a higher accident rate.

The sources of emotional maladjustment predisposing the individual to accidents are many and varied. In some instances they are job-connected. Inadequate relations between a worker and his supervisor are likely to result in such disturbances. Fear of machines, worries about continuing on the job, etc., may produce emotional upsets leading to accidents. In other cases they will arise out of home, family, and financial conditions. Thus the individual involved in marital difficulties may be so depressed that his performance on the job is affected. Some emotional depressions are only temporary or transitory in nature. For example, the bus driver who is normally a safe operator might be unable to concentrate on the job when his child is seriously ill. Other unfavorable emotional states are of longer duration. The individual with chronic financial worries might show a high accident rate over an extended period of time.

SAFETY PROCEDURES

Analysis of Conditions and Causes of Accidents.—In any accident-prevention program the initial step is fact finding. In order to be in the best position to develop preventive measures, a clear and detailed description of the present picture with regard to accidents is essential. Two kinds of information are desirable, viz., data relative to the type of accidents that occur and data relative to the conditions under which these accidents occur.

In the section concerned with the definition of accidents it was pointed out that, in the classification of accidents according to types, three different systems could be used. Accidents can be classified according to the nature of the event, the causes of the event, and the effects of the event. In classifying accidents it is important that these three ways of classifying accidents should be borne in mind. The categories set up should be homogeneous in relation to the particular system used. This system should be wholly concerned with the nature of the accidents, or the causes, or the effects; the different types of categories should not be mixed indiscriminately.

Certain examples of the various types of classification can be cited in order to illustrate their use. In Table 101 are given the accidents of streetcar motormen, classified according to the nature of the event. It is apparent from this table that the major problems were collision accidents, particularly collisions with automobiles. These findings suggest that selective devices, particularly in terms of division of attention, appreciation of spatial relations, and judgments of speed, would be useful.

In classifying accidents according to cause, the most general classification is a division of accidents into those attributable to human error and those attributable to material failure. For industrial accidents it is usually found that some 80 to 90 per cent can be attributed to human error, as compared to 10 to 20 per cent attributable to inadequacies of machines and equipment. This means that preventive measures should emphasize the human factor. It is to be noted, however, that human error does not account for this large a proportion in all cases. With certain types of aircraft accidents, in instances where the cause could be definitely established, it was found that human error accounted for only two-thirds of the accidents.[60] In other cases human error was found to be the cause in only 50 per cent of the accidents. Thus there is still the need for giving considerable attention to the material factors.

Table 101.—Accidents of Streetcar Motormen Classified According to the Nature of the Accident

Nature of accident	Average number of accidents per motorman per month		Accidents, per cent	
Collisions	0.745		95	
Collisions with automobiles		0.680		87
Collisions with other streetcars		0.025		3
Collisions with pedestrians		0.040		5
Noncollision accidents	0.038		5	
Boarding		0.023		3
On board		0.015		2
Total	0.783		100	

Investigations of the effects of accidents will give information primarily relevant to protective measures. Knowing the types of personal injuries and machine breakdown and damage, means can then be taken to prevent similar occurrences in the future. In Table 102 are given the frequencies of different types of injuries resulting from industrial accidents as found in one survey.[61] It is apparent that, among industrial workers, injuries to fingers and eyes are by far the most frequent. Indeed injuries to the various parts of the arms and head account for almost three accidents out of every four. The prime problem obviously lies in the prevention of accidents of this sort.

In addition to information concerning the types of accidents that occur, it is desirable to know something about the conditions under which they occur. Knowledge of these conditions will be of aid in clarifying the accident situation by indicating areas that are particularly acute, in order that preventive measures can be most effectively applied. In previous sections we have touched on various conditions,

TABLE 102.—FREQUENCIES OF VARIOUS TYPES OF INJURIES OCCURRING IN INDUSTRIAL ACCIDENTS

Part of Body Injured	Per Cent of Accidents
Fingers	30.2
Eyes	26.8
Foot	14.6
Hand	9.8
Toes	4.4
Head	3.7
Abdomen	3.7
Ankle	2.8
Leg	1.4
Arm	1.4
Chest	1.0
Knee	0.6
Total	100.0

both environmental and otherwise, which are associated with increased accidents. In an attack on safety problems relative to any particular job, general knowledge of this kind will be helpful principally in providing an orientation for more detailed analysis. As already noted, there are rather marked differences between jobs, and therefore, in a particular case, data specific to that case should be obtained. It will be revealing to procure information concerning the importance of various conditions as they operate in accidents on specific jobs.

As an illustration of the manner in which information of this kind will be useful in accident prevention, a case can be cited from Fisher.[62] In a printing shop the accident rate was found to be about ten times higher on a particular type of press requiring somewhat unique movements than on other presses requiring more conventional movements. Tabulation of accidents by type of press used was therefore revealing of a particular source of trouble. A study of the situation indicated that for most machines the upper press came down slowly and picked off quickly. On the machine in question the speeds of movement were just the opposite. An analysis suggested that the high accident rate was due in part to the fact that the operators were not accustomed to a press with a rapid downward movement and a slow pickup. Further examination indicated that this particular machine movement was not consonant with the natural movements of the operators. It seemed therefore that this machine was inappropriately designed.

Training in Accident Prevention.—In accident-prevention work much emphasis has been given to the development of what has been called the *safety habit*. Although there is considerable looseness in the manner in which the term has been used, nevertheless it is amenable to a rather exact definition. In describing a worker as having or not having the safety habit, we generally are referring to one or more of the following: the degree to which he has developed the particular types of skills and techniques of work that reduce the possibility of accidents, the amount of knowledge he has of the operating rules and procedures and of safety regulations, and the extent of his emotional adjustment insofar as it is pertinent to the safety of his performance. The development of these various skills, knowledges, and adjustments, which may be said to constitute the safety habit, is the problem. They should be the significant areas given consideration in safety education for the worker.

In the development of proper skills and techniques of work, one of the most fruitful approaches in the setting up of a safety training program is a study of the types of inadequate worker performances that lead to accidents. An analysis of this sort will point out the significant errors. In training, these errors can be stressed, and special emphasis can be given to their avoidance. As an example of a study of this kind, the accident-causing errors made by four-engine-airplane commanders are shown in Table 103.[63] The errors given in the table are a simple listing of the errors in performance found in the reports of accident-investigation boards. It is apparent from this analysis that there is no single error of paramount importance, but rather that many different types of errors are made. Since some 60 per cent of errors had to do with one aspect or another of airplane control and operation, it could be said that this aspect of performance needed particular attention in training. Not only does such an analysis provide the training personnel with information concerning the major types of areas that need consideration, but also it reveals the specific errors in performance that should be noted. The frequencies with which the various types of errors are made serve to point out those areas that need particular stress.

In many instances safety training is solely concerned with instruction in operating rules and procedures and in safety regulations. In and of itself such instruction is inadequate, since knowledge of such rules does not necessarily imply that they will be followed. Nevertheless such knowledge is basic to safe operation. The two factors to be considered in the development of knowledge of these rules are the motivation of the individual to learn them, and the rate at which they are forgotten. It is not enough for the worker to be able to recite a long list of safety rules; rather these rules must be very meaningful to

TABLE 103.—ACCIDENT-CAUSING ERRORS MADE BY FOUR-ENGINE-AIRPLANE COMMANDERS

Major grouping of errors		Subclassification of errors		Examples of specific errors
Per cent	Type of error	Per cent	Type of error	
28.9	Operation of flight controls	18.7	Landings	Misaligned with runway Landed with one wing too low
		6.0	Approach	Failed to lower flaps Turned into final approach at stalling speed
		2.4	Mid-air collision while in formation	Flew into turning lead ship Overshot in closing formation
		1.8	Take-off	Retracted flaps Allowed ship to yaw and wing to drop
20.5	Power-plant procedure	7.8	Feathering	Tried to correct yaw by feathering propeller Depressed feathering button and circuit breaker simultaneously
		4.2	Power settings	Reduced take-off power too soon Cruised at too high power settings
		3.0	Instruments	Misread fuel gauges Read Autosyn instruments as direct reading
		2.4	Mixture controls	Used emergency-rich too long Set mixture to auto-lean to eliminate torching
		3.0	Miscellaneous	Tried to reduce cylinder-head temperature by opening cowl flaps to maximum Tried to reduce cylinder-head temperature by feathering
12.0	Supervision of crew	4.8	Supervision of crew as a whole	Failed to notify crew to prepare for crash landing Did not post crew member in front of airplane to guide him out of parking area
		3.6	Supervision of co-pilot	Permitted co-pilot to stall on landing without intervention Allowed co-pilot to fly entire pattern with gear down
		2.4	Supervision of navigator	Did not require position reports of navigator Failed to keep navigator informed of fuel consumption
		1.2	Supervision of engineer	Did not require engineer to make continuous oral air-speed readings Directed engineer to make fuel-selector changes when not necessary
10.9	Operation of auxiliary controls	7.2	Landing gear, landings	Did not check gear down Intended to lower gear but by mistake retracted flaps
		1.8	Landing gear, take-offs	Retracted gear too soon

TABLE 103.—ACCIDENT-CAUSING ERRORS MADE BY FOUR-ENGINE-AIRPLANE COMMANDERS.—(*Continued*)

Major grouping of errors		Subclassification of errors		Examples of specific errors
Per cent	Type of error	Per cent	Type of error	
		1.8	Miscellaneous	Applied brakes before airplane was airborne Did not use landing lights while taxiing at night at close quarters
9.1	Judgment			Attempted to go around after committed to two- or three-engine landing Flew into very turbulent cumulus
8.4	Radio technique and cockpit procedure	3.6	Communication with tower	Did not monitor tower before and during landing Reported wrong ship number to tower
		1.8	Radio equipment	Not proficient with radio compass or command receiver
		1.2	Communication with flight leader	Failed to notify flight leader he was going on three-engine operation Failed to notify flight leader he was leaving formation
		1.2	Check list	Did not complete check list
		0.6	Interphone	Poor interphone procedure
6.6	Observation and orientation			Gave sole attention to instruments, ignoring terrain Failed to observe other airplane in flight
3.6	Safety and air regulations			Violated tower altitude instructions Made instrument letdown through traffic pattern at night

him personally. By making the rules really meaningful for him, they are more likely to influence his behavior. Even with proper initial learning, however, the worker can be expected to forget certain of the rules with the passage of time. It follows therefore that periodic tests of knowledge of safety rules should be administered as a check. If the amount forgotten is significant, then retraining is in order.

As was indicated earlier the emotional adjustment of an individual is an important factor in the safety of his performance. The well-adjusted worker can be expected to have fewer accidents than the poorly adjusted one. Safety education therefore should provide for some discussions of the topic of mental hygiene. Orientation of the individual toward his job and to the organization, as well as orientation in relation to his personal affairs, needs treatment in this respect. Although the treatment of problems of adjustment is commonly considered to be a matter requiring individual counseling, nevertheless many aspects of personal orientation can be successfully dealt with in group discussions.

Clinical Approach to Safety.—The clinical method is essentially a process of studying the factors that underlie an individual's behavior. The aim is to determine the various forces and influences operating upon the individual, and his personality and abilities through which they operate, so that a final integrated picture useful in explaining his past behavior and in predicting his future behavior can be obtained. Both fact finding and analysis are important constituents of the method. Pertinent facts are uncovered from an investigation of the individual's personal, social, and work history and from various types of descriptions of his emotional make-up and capacities, and these are evaluated, weighed, and integrated into a total pattern descriptive of that person.

In most if not all cases the essential element of the clinical process is the judgment of the clinician. Controls of the sort that can be effected in scientific investigation are next to impossible. Knowledge of the importance of a factor operating in a particular situation can be obtained in a scientific study by holding constant all factors but the one to be studied. For example, the relationship between marital status and industrial accidents among workers can be determined by comparing the safety of two groups of workers who are equated for age, experience, etc., but who differ only in that one group is married and the other is single. In a study of the importance of marital status in a particular individual's accident rate, however, these types of controls cannot be effected. One can never determine scientifically what this person's performance would have been had the circumstances been different. Therefore for the individual one must evaluate and weigh the pertinent facts as best one can. The clinical method therefore is necessarily an art: an art in knowing what information to seek, how to obtain it, and how to analyze and integrate it into a final clinical description of the person.

From the foregoing discussion it is apparent that the adequacy of the clinical analysis of the accident maker will be a function of the adequacy and ability of the clinician to obtain and interpret information, and of the adequacy of the tools available to him for obtaining information. It is beyond the scope of the present discussion to describe the qualifications of the clinical psychologist. Suffice it to say that the clinical psychologist needs an extensive and specialized professional training, together with experience in the use of diagnostic techniques and analytic and interpretative methods.

The tools employed by the clinician in obtaining information about the individual must be evaluated just as the tools used in the selection and classification of workers are evaluated. The major difference is that the tools used by the clinician should be validated against specific traits or aspects of job performance, whereas those used in selection and classification may be evaluated in terms of their predictability of general or over-all performance. For example, if the clinician is interested in ascertaining whether an individual's reaction time is an important factor in his high accident rate, scores on the reaction-time test must be demonstrated to be related to those accidents where speed of reaction is judged to be important. Thus Fletcher, in evaluating the diagnostic value of a test of field of vision, compared the intersectional accidents of a group of automobile drivers with their test scores.[64] He found that, with persons for whom the test indicated restricted vision on one side, the number of fatal intersectional accidents in which they were involved was six times greater on the deficient side than on the normal side. It is apparent then that scores on this test were diagnostic of a particular kind of difficulty of automotive operators. This type of evaluation is needed for all the tools used by the clinician in dealing with the individual case.

The types of information the clinician will require in dealing with the individual accident case have been considered by Shellow.[65] Information such as the following ordinarily is gathered for the case analysis:

Length of service
Marital status
Home conditions
Job attitude
Test results
Age
Health
Interests and background
Personality
Summary of number and kinds of accidents

Pertinent data will be obtained from a variety of sources. Personnel records will be consulted, reports by instructors and supervisors will be sought, accident records and reports will be consulted, and the clinical psychologist will obtain information from the worker directly through an interview. The data will be analyzed and integrated so that a satisfactory explanation of the individual's past unsafe performance is obtained. Then the clinician will recommend a procedure designed to effect an adequate adjustment. A summary of a psychologist's recommendations for a group of high-accident motormen who passed through an accident clinic is given in Table 104.[66]

TABLE 104.—PSYCHOLOGIST'S RECOMMENDATIONS RELATIVE TO A GROUP OF HIGH-ACCIDENT MOTORMEN WHO WERE STUDIED IN AN ACCIDENT CLINIC

Recommendation	Per Cent of Men
Training and follow-up	56.0
Now considered safe	18.5
Referred to division superintendent or safety director for interview	7.4
Referred to superintendent of transportation for interview	5.6
Asked to leave service	5.6
Transferred to conductor	7.4
Examination by Medical Department	1.8

The evidence relative to clinical procedures is exceedingly gratifying. Thus Shellow reports that the accident rate of a group of high-accident motormen was reduced 82 per cent after having been subjected to clinical procedures.[67] Fletcher has reported a reduction in accidents of some 50 per cent for commercial drivers who have been treated in an accident clinic.[68] More impressive evidence is cited by this investigator wherein the accident rates of over four hundred automotive operators were determined before and after they passed through accident clinics and compared with the rates for the same period of a comparable number of men who were not clinically studied. The clinically examined group showed a reduction of accidents after treatment amounting to more than 60 per cent, whereas the accident rate of the untreated group remained unchanged.

The evidence presented above, relative to the effectiveness of the accident clinic as a means of reducing accidents, is only a sample of the positive findings.[69] It appears to be the best single method of reducing accidents insofar as the human factor is concerned. The integration of the work of the clinical psychologist, the industrial physician, and the psychiatrist relative to accidents undoubtedly would have a profound effect upon the safety of industrial operations. The major difficulty lies in the fact that the accident clinic requires the service of trained, professional personnel, a service that is expensive. However, in view of the importance of accidents in the physical, mental, and social welfare of workers, the cost of such services should not be a primary concern.

Safety Publicity.—No safety program would be complete unless it included some type of publicity designed to condition the worker toward safer operation. A survey of the literature relative to safety publicity, however, will indicate that the present stage of development of this field is comparable to the stage of commercial advertising some twenty or thirty years ago. Systematic procedures have played little part as basic methods in the planning of safety publicity. The general point of view is that its creation and development constitute an art and that scientific methods can play little part.

By and large, discussions of safety publicity have been concerned with the effectiveness of different types of publicity as indicated by haphazard, casual, and unscientific observation. The effectiveness of systematic market-research techniques in the development of advertising has been adequately demonstrated, and descriptions of these techniques are readily available.[70]

No attempt will be made here to outline in detail the direct application of market-research methods to safety publicity. A few general comments, however, are in order. In the development of safety publicity three distinct problems should be taken into account: first, the obtaining of information relative to the determinants of the behavior in question, secondly, the obtaining of information relative to the reading and listening habits and capacities of the workers under consideration, and, finally, the evaluation of the effectiveness of the publicity.

The first area will provide a systematic attack designed to yield significant information that will be of aid in determining the nature of the publicity, such as the types of appeals most likely to be effective. The second type of information will be helpful in planning the type of publicity to be used, whether pamphlet, poster, etc. Finally, checks on effectiveness will be as necessary here as with any other industrial procedure. Obviously the best check on the effectiveness will be in terms of the reduction of accidents, but partial checks will be provided by tests of the attention-getting power and the memory power of the publicity.

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CHAPTER XV

MONOTONY

The last three decades have witnessed a marked shift in industry from the more complex, varied, and individually planned work of the skilled craftsman to the simpler, uniform, and repetitive work of the semiskilled production-line operator. Particularly during the last war, many jobs that hitherto had been performed by skilled workers were reanalyzed and broken up into several different subjobs, each of which could be performed by persons of far less training and experience. The reasons for this change have been many, but economic and technological considerations appear to be the major factors. Insofar as the human side of the picture is concerned, the only justification offered has been the reduced amount of training required by the worker to perform the job adequately. For an industrial task requiring a high degree of skill, training time will be in terms of years, whereas for a simpler task, training time will be in terms of hours, days, or at the most, weeks. From the psychological point of view this is clearly an inadequate justification for the substitution of the simpler repetitive tasks. Factors such as the morale, adjustment, and welfare of the worker should also be considered.

The increasing number of simple repetitive tasks in industry has impelled many writers to fill page after page with verbose explications of the evil effects of the system. Unfortunately most of these discussions are of a more or less romantic sort and contribute little toward a scientific explanation of the basic problem. The presupposition in these writings is that all repetitive work is monotonous, and monotonous for all workers. This proposition will be examined later. It should be pointed out, however, that repetitive work is not an innovation of the industrial age. The pneumatic-hammer operator and the multiple-loom tender of today are probably no more or no less bored by their work than were the ancient hewer of stone and weaver of cloth.

In the present chapter we shall examine the nature of monotony and its relation to repetitive work. We shall also consider some of the major factors leading to monotony, its effects on production, and procedures for overcoming or minimizing it.

THE NATURE OF MONOTONY

Definition.—Monotony or boredom is a mental state of the individual. Like feelings of tiredness or feelings of effort, it is difficult to define. Monotony is similar to feelings of tiredness in that it is unpleasant, a state that the worker seeks to avoid, and similar to feelings of effort in that it is a concomitant of continuous work. Monotony may be defined as satiation for a given activity that the individual is compelled to continue.[1] In essence, monotony arises out of a conflict situation. The individual desires to discontinue an immediate uninteresting activity, the cessation of which he realizes would endanger the achievement of somewhat more distant goals or rewards. There may be a lack of sense of accomplishment and even a feeling of futility in continuing the work. The feeling tone in monotony is perhaps best described as dull and unpleasant, but such a description would certainly be incomplete. It must be admitted that the mental condition of boredom is not easy to describe.

In the industrial situation boredom becomes manifest when the individual finds his work presenting no challenge, and when his interest in the immediate accomplishment of that work is gone. He fully realizes that, unless he continues to produce, he will not be paid. His pay, however, will not be received for a week, or perhaps for a month. The monetary rewards for his labor therefore appear to be in the far-distant future, and the pleasures to be derived from them are remote, whereas his job is before him and the unpleasant tasks must be done now. He will therefore seek every dodge to avoid the immediate task without endangering the achievement of his ultimate goal of economic security. He thus finds himself in a condition of motivational conflict, which, though minor, will be unhealthful mentally, and its effects on performance will be deleterious if it is of long duration or of frequent occurrence.

Monotony and Feelings of Tiredness.—In many instances it is difficult to distinguish between boredom and feelings of tiredness. Both are the results of work, and both are unpleasant. To produce monotony, work must be carried on for a period of time, and feelings of tiredness resulting from the earlier phase of the activity will be manifest in the later part of the work spell, when monotony can be expected to occur. It is apparent then that the criterion of whether the mental state occurs early or late in the work period does not adequately differentiate the two states.

Furthermore both states impel the worker to seek a change. The desire to change from boring work may be satisfied by changing to another type of activity, whereas feelings of tiredness move the individual to seek rest. Attempting to differentiate the two states on the basis of whether the change sought is rest or simply a different activity may be difficult, since the condition of rest itself is not easy to define. An individual may become weary as a result of a certain activity and "rest" himself by engaging in some other activity. A person after reading an interesting book for a long period of time may find that his eyes are tired and his mind somewhat befogged. He then takes a rest by walking around the block, chopping wood, or writing a letter. The "rest" in this case is not necessarily either physical or mental inactivity but rather some other type of activity.

The difficulty of distinguishing between boredom and tiredness has led some investigators to suggest that the two be considered the same mental state.[2] Certainly many methods that have been found useful in overcoming the one mental state have been found useful in overcoming the other. Nevertheless, on occasion, workers do distinguish between the two. They report that the work on a given job is not particularly tiring, but that it is boring; or, that the work is interesting but tiring. In one study of factory workers under conditions of the normal working day, numerous complaints about boredom were found, but there were seldom reports made of tiredness.[3] It was only when the length of the working day was increased, as in the case of overtime, that complaints about tiredness were made in significant numbers.

EFFECTS OF MONOTONY

Behavior of the Bored Worker.—The behavior of the worker when engaged in a monotonous task has been described by a number of writers.[4] When he approaches the job at the beginning of the new working day, he does so with some measure of enthusiasm, feeling ready to go ahead with it. His interest, as manifested by his concentration on the work in hand, continues for an hour or so. As boredom gradually develops, his attention fluctuates from his task, he becomes restless, changes his bodily position, contorts his face and mouth, yawns, licks his lips, glances at the clock, or leaves his workplace at the slightest excuse. As the end of the work spell approaches, these activities may gradually disappear. It is significant in this connection that in interviews with workers they stress the middle of the working spell as being most monotonous.[5]

Effects of Boredom on Production.—Although the total production of a bored worker is not necessarily less than that of a worker who is not bored, the effects of monotony are nevertheless reflected in output. The output curves of workers who report that a job is monotonous generally are characterized in the middle of the work spell by a drop in output and an increased variability in speed of work.[6] The rate of production of such workers is higher at the beginning and end of the work period than it is in the middle. Furthermore during the middle period the rate of work is less constant or steady, the individual working in spurts and stops and his output being characterized by alternating short periods of diminished and of increased rates of work. These changes in output are just what might be expected from the description given above of the behavior of the worker engaged in monotonous work. As the initial interest in the work diminishes and monotony appears, the worker's attention to his work fluctuates. This fluctuation in attention produces the variability in working speed and the reduced output found during the middle period.

Monotony and Reverie.—The thoughts of the worker relative to his home life, social affairs, financial problems, and similar matters not directly concerned with his job are not confined to those hours of the day that he spends outside the plant or office walls. They occur during breaks and delays in the working period or when the task is not particularly demanding of attention. Indeed, if the worker's personal problems are of great importance to him, work may be slowed up or even stopped while he mulls them over. This reverie, even though it concerns problems apart from the job, is not unconnected with the job. As Mayo has pointed out, any tendencies toward pessimistic meditation may be minimized or intensified by the nature and conditions of the individual's daily work.[7] When the nature or conditions of work are either mentally or physically unsuitable, the effect is to increase pessimistic reverie. A job that has little or no intrinsic interest to the worker and does not receive his entire attention will therefore be a predisposing stimulus for such gloomy meditation.[8] Monotony therefore is likely to be associated with unpleasant reverie and develop undesirable attitudes in the worker. This state is relatively impermanent and easily modified. Changing the working conditions or placing the worker under more favorable circumstances that alleviate the monotonous character of the job reduces or eliminates these unhappy chains of thought.[9]

It should not be inferred from the foregoing discussion that the repetitive nature of the work itself produces the pessimistic reverie.

It is to be remembered that the terms *repetitive work* and *monotonous work* are not synonymous. If the job is repetitive, but not monotonous, the character of the reverie is very likely to be pleasant. Under such circumstances the worker indulges in flights of fancy, building castles in the air, and experiencing romances, which, as imaginal experiences, are fulfilling some want that he considers important.[10] Although from a mental hygiene point of view such daydreaming may not be considered wholly desirable, from the worker's point of view it results in satisfaction, and certainly it is not an unpleasant experience.

Effects on Mental Life.—The individual who works for relatively long periods of time at a task that for him is highly monotonous may experience a change in his mental life. Objects, activities, and people that he has heretofore found to be stimulating and interesting become neither exciting nor engaging. He becomes dull, less alert, and less responsive to his environment, and he feels that he is less intelligent than formerly.[11] The caliber of his work, however, may not suffer. The chief change is in the character of the worker's mental life and in the reduced participation in normal extra-job activities. As one group of girls engaged in a monotonous task expressed it, they felt that they were becoming turnips.

This generally dulled mental life appearing as a result of continuing on a boring task is not so easily overcome as the pessimistic reverie described earlier. On the other hand the effect seems far from being permanent. Depending upon the type of individual, the length of time he has worked at the monotonous task, and other related variables, his outlook will return to a normal state in a period of a few weeks after he has ceased working at the monotonous job.

Effects on the Personality of the Worker.—The unpleasant reverie and dulled mental life resulting from long-term assignment to monotonous work are certainly not to be desired, even though they are readily avoided or are fairly easy to overcome. In themselves they usually are not psychologically dangerous, but they may lead to very serious disturbances of another kind. Semipermanent or even permanent effects on the individual's personality may result from prolonged pessimistic reverie or dulling of the mental life. These changes toward maladjustment may involve irrational fears concerning quite safe pieces of machinery or abnormal anxieties relative to fellow workers, output, or health. There may be certain delusions about supervision, or feelings of self-guilt. In a few cases such tendencies may be the beginnings of true psychopathic disorders of a severe sort, which eventually will require extensive psychotherapy.[12] Although the proportion of persons working at repetitive jobs who are likely to develop such disorders is probably very small, the end results are far too serious to be entirely ignored.

THE NATURE OF THE WORK AND MONOTONY

Repetition and Monotony.—Implicit in the criticisms of repetitive work is the assumption that all work of this kind is necessarily monotonous and monotonous for all persons. Although it cannot be denied that more persons will report a repetitive task as being boring than a nonrepetitive task in which the activities are varied, nevertheless the assumption just stated cannot be considered valid. There are too many examples, among industrial workers engaged in repetitive work, of individuals who do not find their jobs boring. Indeed many workers actually report such tasks as being interesting.

The evidence certainly does not indicate that repetition, in and of itself, is the major determiner of monotony in industrial work. The facts in opposition to this thesis are, first, that for the same repetitive task all individuals are not bored; secondly, that changing the conditions of work, but not the repetitive nature of the task, reduces or eliminates monotony; third, that changing the nature of the incentive, but not the task, reduces or eliminates monotony; and, fourth, that on varied and nonrepetitive tasks some workers report that they are bored. This is not to argue that repetition is not a factor leading to monotony, but rather that the unvarying nature of the task leads to monotony only with a particular individual, under certain conditions of work, and with an inadequate motivating situation. The notion that there is an inherent dislike for repetitive work has never been substantiated and should no longer be maintained.

Repetitive versus Varied Work.—To test the effects of repetition on monotony and output, a task is needed that may be broken down into two or more independent operations. Work is then carried on under two schedules, one where any one of the operations alone is performed throughout the day, and the other where the different operations are alternated in varying amounts. Wyatt,[13] and Wyatt, Fraser, and Stock,[14] compared the effects of uniform and varied methods of work on such jobs as the checking and packing of drugs, the wrapping and packing of soap, the folding of handerchiefs, and the making of cigarettes by hand. Under the uniform conditions of work the worker performed the same activity over and over again, and in the varied method the cycle of work involved several different tasks. For example, in handkerchief folding under uniform conditions of work the same style of folding was maintained throughout the entire day, whereas for the varied conditions the style of folding was changed at approximately hourly intervals. For the varied condition of work on these jobs the incidence of boredom was substantially reduced, and output was increased approximately 5 per cent. The general conclusion that may be drawn from these investigations is that varying the conditions of work considerably decreases the monotonous aspects of the work and in addition slightly increases output.

Effective Variations in Work.—From the results of a series of studies on the effects of variety and uniformity of work, Wyatt, Fraser, and Stock concluded that the beneficial effects of variation are a function of three conditions, viz., the nature of the alternating activity, the frequency of the change, and the type of work.[15] The beneficial results will be better for certain types of alternating activities and with certain frequencies in change in activities than with others, and these benefits will be found greater for some industrial tasks than for others.

As far as the nature of the alternating activity is concerned, it appears that the greater the difference between the activities alternated the more favorable will be the results obtained. For example, in the investigation of handkerchief folding, where the alternation consisted only in making a different kind of fold, the varied procedure of work produced an increase of only 1 per cent in output. In the study of tobacco weighing, where the work involved the somewhat more varying operations of cutting, twisting, weighing, and wrapping of tobacco, output was increased as much as 14 per cent.

TABLE 105.—FREQUENCY OF CHANGES IN THE ACTIVITIES INVOLVED IN THE MAKING OF CIGARETTES IN RELATION TO OUTPUT

Method of Work	Relative Output
Making all day	100
Making for 1 hr., then cutting	112
Making for 1½ hr., then cutting	113
Making for 3 hr., then cutting	106
Making and cutting alternately according to the inclination of the worker	107

The results indicate that insofar as output is concerned, there is an optimal frequency of change in operations, alternations of greater or less frequency being less effective. Illustrative findings are shown in Table 105.[16] In this investigation cigarettes were made by hand by inserting the tobacco into the paper and cutting off the protruding ends of the filler. The comparison of various time intervals of making cigarettes followed by periods for trimming the ends indicated that making for 1½ hr. and then cutting produced greater output than any other time schedule. Another significant fact will be noted from Table 105. In agreement with other investigations it is found that a systematically scheduled alternation, if the alternation times are judiciously selected, is a more effective procedure than permitting the workers to alternate according to their own inclinations. The individual worker is apparently not the best authority on the optimal length of the alternation periods. Rather the alternation times must be determined empirically and in terms of the specific factors operating in the given job situation.

It is apparent that certain types of work will undoubtedly benefit more from variety than others. Wyatt, Fraser, and Stock found rather marked differences in the benefits resulting from the introduction of variety in the work demanded by different industrial activities.[17] One of the jobs they investigated, the assembly of cartridge cases, involved three distinct processes that were done consecutively. These processes were stacking, assembling, and pushing down of wads. In performing the job the operators worked with one tray of cases at a time, completing all three processes on all cases in that tray before working on another tray. The speed of work for each of the three processes could be determined separately since each process was completed before beginning the next. By using trays containing different numbers of cases, variations could be effected in the frequency of change from one task to another. Table 106 gives the relative speed of work with which each of the three tasks was performed in relation to the size of the trays. From the table it will be observed that

TABLE 106.—SPEED OF OPERATION IN EACH OF THE THREE OPERATIONS INVOLVED IN ASSEMBLING CARTRIDGE CASES IN RELATION TO THE NUMBER OF ITEMS OF WORK (NUMBER OF ITEMS IN ONE TRAY OF WORK) COMPLETED IN EACH OPERATION BEFORE CHANGING TO THE NEXT OPERATION

Items of work in one tray	Relative speed of work		
	Stacking	Assembling	Pushing down wads
750 (frequent changes)	100	100	100
1,000	109	108	106
1,250	113	107	102
1,500 (infrequent changes)	115	93	96

marked differences obtain between the tasks in terms of optimal frequency in change of tasks. Within the limits of this experiment, stacking showed an increase in speed with each decrease in frequency, whereas assembling and pushing down the wads showed a decrease. It is therefore clear that some industrial tasks benefit more from variation than do others. There is as yet inadequate information on which to base conclusions concerning the specific nature of the tasks benefiting most from the introduction of variety.

INDIVIDUAL DIFFERENCES IN SUSCEPTIBILITY TO MONOTONY

Variation among Workers.—Since Munsterberg's observations many years ago, it has become increasingly clear that individuals differ markedly in the extent to which they experience monotony even in highly repetitive work.[18] From different workers on the same job, reports will be obtained ranging from almost unbearable monotony to rather intense interest. Wyatt and Langdon obtained reports from workers in four factories concerning the degree of boredom they experienced in their work.[19] Certain of their findings, given in Table 107, show the extent of variation among workers. The work of these investigators, however, indicates that susceptibility to boredom is not a general characteristic of the individual but is a highly specific factor. In Table 108 are given the estimates made by 10 workers of the degree of boredom they experienced on five different industrial tasks, every worker having spent 1 month on each task. It will be seen that for a given task there is generally considerable variation from worker to worker. In addition, it will be observed that there is con-

TABLE 107.—DIFFERENCES IN EXTENT OF MONOTONY AS REPORTED BY WORKERS IN FOUR DIFFERENT FACTORIES

Degree of monotony	Factory			
	A	B	C	D
	Per cent			
Practically free from boredom	1	3	5	3
Slightly affected by boredom	26	42	39	13
Moderate degree of boredom	43	37	33	37
Suffered severely from boredom	28	16	19	30
Never free from boredom	2	2	4	17
Total	100	100	100	100

siderable variation within each individual. A task that one person considers very boring will be considered by another as almost free from boredom. It can be concluded that for any particular task individuals will vary markedly in the extent to which they are bored, and that susceptibility to boredom is very definitely not a general trait of the individual but, for a particular person, varies markedly from one task to another.

TABLE 108.—ESTIMATES MADE BY 10 WORKERS OF THE EXTENT OF BOREDOM THEY EXPERIENCED ON FIVE DIFFERENT INDUSTRIAL TASKS

Task	Worker									
	A	B	C	D	E	F	G	H	I	J
Packing (14 lb.)	0.4	0.7	3.5	1.4	1.0	1.1	0.9	3.2	0.8	3.6
Packing (4 lb.)	1.5	1.1	4.0	2.5	0.3	1.9	0.5	2.6	1.5	1.0
Staying boxes	1.9	2.0	1.1	1.6	2.1	5.7	3.2	3.0	1.6	1.5
Making crackers	4.0	4.8	1.8	3.7	3.4	1.0	0.3	1.2	2.0	1.9
Bundling chocolates	4.2	4.6	4.3	4.8	3.2	4.4	4.1	4.5	3.8	4.0

0–1 Practically free from boredom.
1–2 Slightly affected by boredom.
2–3 Moderate degree of boredom.
3–4 Suffered severely from boredom.
4–5 Never free from boredom.

Intelligence Test Scores in Relation to Monotony.—The fact that labor turnover on simple jobs is found to be greater for individuals making high scores on intelligence tests than for those who earn low scores has suggested to many investigators that general intellectual ability is directly related to proneness to monotony.[20] These findings, however, cannot be considered as final proof that susceptibility to boredom is a function of general intellectual ability, since superior individuals leave simple jobs for many reasons, only one of which is the monotonous character of the work.

Burnett studied four girls engaged in the repetitive work of cross-stitching.[21] Two of these girls, who made rather high intelligence test scores, displayed the typical symptoms of boredom, such as yawning and restlessness, and their speed of work was characterized by a high degree of variability. The remaining two girls, one of whom made an average test score and the other a low score, did not complain of boredom and appeared to be satisfied with the work. These findings are suggestive of a relationship between susceptibility to boredom on repetitive work and intelligence test scores. The degree of this relationship, however, is not apparent from these data.

A more extensive investigation by Wyatt, Fraser, and Stock gives more detailed information on this relationship.[22] The output curves and subjective reports of their feelings obtained from 10 girls who earned high scores on intelligence tests were compared with those of another 10 girls who made low test scores. Not all these girls were working on the same job, but in all jobs the work was routine. The jobs involved were tobacco weighing, chocolate packing, soap wrapping, winding electric-light filaments, and inserting hooks into electric-light bulbs. All the individuals of the group who made superior test scores described the work as boring, particularly in the middle of the work spell, and six of the ten complained rather vigorously of monotony. On the other hand, only five of the group with low scores mentioned that the work was sometimes boring, but none described the work as very monotonous. The reports of the other five girls who earned low scores indicated that they were contented with their work. The difference in subjective reports is confirmed by the fact that on the average the drop in output in the middle of the work spell for the group earning high test scores was 9 per cent, whereas for the group earning low scores it was only 2 per cent. These results offer additional evidence for the belief that repetitive work is more likely to be monotonous for persons who earn high scores on an intelligence test than for those who earn low scores. In evaluating these findings, however, it is important to remember that two quite extreme groups in terms of intelligence test scores were compared. If cases with intermediate scores had been included, it is likely that the relationship would have appeared much lower, and many reversals would have been found between size of test score and extent of boredom.

Thompson devised a questionnaire designed to measure an individual's tendency toward variety or uniformity in daily habits.[23] This was administered to 32 subjects, and the scores were combined with ratings by associates on susceptibility to monotony. In addition susceptibility to monotony for several routine tasks was measured by the decrement occurring in production. Coefficients of correlation between scores on an intelligence test and these various criteria of susceptibility to monotony did not differ greatly from zero. Although Thompson's study might be open to question relative to the means used for indicating susceptibility to monotony, it may be considered to contribute evidence supporting the view that such susceptibility bears only a low correlation with general intellectual ability.

Other Abilities and Traits.—The importance of psychological traits other than general intellectual ability in susceptibility to monotony has been given very little attention. Ability to perform the work involved in the job appears to be completely unimportant as a factor, since the complaints of boredom on the part of high producers on a job are usually as frequent as those of low producers.[24] There are some indications that emotional stability is an important condition,[25] but much more research needs to be done in the area of personality before there will be sufficient data for determining the relative importance of various personality factors.

THE RELATIONSHIP BETWEEN THE INDIVIDUAL AND THE TASK

Thus far it has been shown that although the nature of the task and the psychological characteristics of the worker are related to monotony, they cannot be considered to be major determiners of monotony. Although these two factors in and of themselves may be relatively unimportant, the relationship between them is of paramount importance. The attitude of the worker toward the task presented him and toward the conditions under which he has to work plays a large part in determining whether or not he will be bored with his job. As Davies puts it, monotony is a reaction to the whole set of circumstances surrounding work and not to particular selected features of it.[26] Clearly it is important to examine the nature of this relationship and to consider factors in the working situation having some bearing on the worker's attitude toward his job.

Degree of Automatism of the Work.—Industrial tasks can be considered in terms of the degree to which they are demanding upon the worker's attention. Although obviously all tasks require at least a minimum of attention, for some tasks, either because of the simplicity of the operations involved or because of their habitual nature, the worker need devote very little of his attention to the job. Certain assembly and packing operations are of this sort. Such jobs may be performed almost completely automatically. On the other hand there are certain tasks that, at least for extended periods of time, require almost the entire attention of the worker. Thus the bus operator on a busy run and the clerk who adds and balances a series of figures must necessarily concentrate closely on the task in hand. Activities such as these cannot possibly be performed in an automatic fashion.

In between these two extremes are a number of jobs requiring intermittent close applications of the worker's attention. It may be that for a given job certain of the activities can be done in an automatic fashion, whereas others present novel problems, or perhaps the job operations are of such a nature that they can generally be performed in an automatic fashion with frequent close attention when checks are made of the quality of the work. An illustration of work of this kind is that of the bottling-machine operator. With certain types of machines the bottles are placed into the machine by hand, and the amount of fluid delivered into the container is controlled by the worker. These operations can be done automatically by him and require little attention. However, frequently the supply of bottles is interrupted, or he receives an imperfect bottle, or he misjudges the amount of fluid delivered. These variant situations occur at irregular and unexpected times and require an immediate and fully conscious adjustment. Such work might be termed *semiautomatic* since it is partly attention demanding and partly automatic.

Semiautomatic jobs are found at all occupational levels and are not restricted to the manual occupations. Consider the job of the airplane pilot. To be sure, while flying a traffic pattern and in landings and take-offs, his entire attention to the task in hand is required. The amount of time consumed by such activities, however, is only a relatively small proportion of his total working time. While flying cross country on a set course and with at least reasonably good weather conditions, he needs only occasionally to check closely his instruments and surroundings. Under these conditions his work is truly semiautomatic.

Contrary to expectation it is not the jobs that can be done in a completely automatic fashion that are most likely to produce monotony. Rather, boredom will most probably appear when the individual finds it necessary to devote some but not all of his attention to his work. When the individual can perform his work with little or no attention to it, or when the work demands his complete attention and interest, the job is less likely to be reported as being monotonous. In other words monotony is less likely to occur with work that is completely automatic or with work that demands a high degree of attention, and more likely to occur in the case of semiautomatic work.[27]

The explanation of this state of affairs is not difficult to understand. On the one hand a job that is completely automatic leaves the worker free for reverie or, if the working situation permits, conversation and social intercourse with his fellow workers. On the other hand, work that requires complete attention does not allow for reverie, and unless it has a high degree of intrinsic interest for the individual it will not be continued without letup for an extended time. Semiautomatic activity, however, because of its very nature may well have low interest value, but because it does on occasion demand a high degree of attention it will not permit the individual to make the wholly satisfactory attentive adjustment that he can make to highly automatic work.

It must be understood that the relationship described above between the degree of automatism of the work and monotony is only a general tendency. Some tasks that are either completely automatic or require a high degree of attention are reported as boring. In the one case the worker may not succeed in making a satisfactory adjustment in terms of extra-job activities such as conversation with fellow workers; and in the other, even though the work receives the greater part of the worker's attention, it still may be intrinsically uninteresting. Compared with these, semiautomatic work neither permits freedom of thought nor is sufficiently demanding to keep the individual's mind fully occupied.[28]

Challenge to the Individual.—It is easy enough to make the obvious statement that uninteresting work will be boring, but such a statement is too general to be helpful. An interesting job is one that absorbs the attention of the individual and in one way or another has a certain worth-whileness for him. Such a job stands as a challenge to him. Although perhaps it does not require the utmost of an individual's energies and talents, it nevertheless calls on him to exercise his abilities to a considerable extent. In other words an interesting job is one that presents a challenge to the individual. It is neither too difficult nor too easy for him to accomplish and has certain ego-satisfying characteristics.

A task that does not challenge the individual is likely to be reported as boring.[29] There is nothing in the task itself that holds the attention of the worker or requires of him the type of response that he feels he is particularly capable of making. However, even if the nature of the task itself does not hold the individual, there may be other elements connected with the job situation that attract him. That is, the interest factors need not be relevant to the work itself but may be completely external to it.[30] The social situation in which the individual works, a particularly compatible management, realization of the need of high production for a war effort, possibility for future advancement, etc. might present challenges of a more general kind, which reduce or prevent the occurrence of monotony.

CONDITIONS OF WORK

Length of the Work Period.—Since boredom and its effects on output do not appear during the early portions of the work spell, it would seem that they would be less likely to occur in shorter than in longer work periods. Vernon obtained results indicating some validity for this notion.[31] Working two subjects for 4- and 8-hr. periods on simple routine tasks, he found that only for the 8-hr. period of work was there a falling off in speed of work in the middle of the working spell. It would seem that with longer work periods the individual does not see relief from the uninteresting task forthcoming in any reasonable time and thus the unpleasant mental results of the work accumulate to produce extensive feelings of monotony. The day's work before him appears unending. With the shorter periods of time the worker at least can appreciate the fact that the work will be terminated within a span of time that is strictly limited in terms of a living day. The relief from the unpleasant task is close enough to appear real.

Rest Pauses.—In practice it is ordinarily impossible to reduce the working day to a period as short as 4 hr. Somewhat the same effect, however, can be obtained by breaking up the working day into periods separated by rest pauses. A number of investigations have shown that the introduction of correctly spaced rest pauses reduces the incidence of monotony.[32] The effects of rest pauses are reflected not only in output but also in the reports of the workers. Mayo, for example, found that, when rest pauses were introduced in a textile mill, production increased, and the attitude of the workers toward their job improved markedly.[33] Labor turnover in the mill had been high, and, if it was not directly due to the monotonous character of the work, it was indirectly due to it. After the system of rest pauses was put into effect the labor turnover was reduced to a negligible amount.

SOCIAL INFLUENCES IN MONOTONY

The Social Situation.—As has been suggested, the interest value that an individual's job has for him does not arise solely from the nature of the industrial task itself but arises in part from the social features of the situation in which he works. The character of the group with which the individual works, the relationships between the persons who comprise the group, and the relations with supervisors and management are powerful factors in determining the individual's adjustment to his work, his attitudes, and his performance.[34] In many instances these factors are far more important than the nature of the work and working conditions. It is apparent therefore that with an unfavorable social situation boredom is more likely to occur. On the other hand, when the relationships with other workers and with management are favorable, the job may not appear to be monotonous to him even if the work itself has no great appeal to him.

One particular type of social situation has been investigated by Wyatt, Fraser, and Stock.[35] These investigators found that, when workers are given the opportunity to engage in conversation, complaints of monotony are markedly reduced. If the worker is isolated from his fellows, either physically or by administrative edict, and if his industrial task is uninteresting to him, monotony will ensue since he cannot use social intercourse as a means of developing job interests. The indication is, however, that talking has an adverse effect upon output. Thus, if one is willing to sacrifice a certain amount of output, it seems likely that considerable gains will be achieved in terms of a reduction in monotony and a consequent increase in employee morale. Further studies in this field are needed. It might prove that the drop in production that seems incident to the social conversation is only temporary, and that after several months the production is as good as or even better than it was under the condition wherein the worker is prevented from conversing with his fellows.

Effects of Suggestion.—Davies has pointed out another manner in which social influences may operate.[36] Complaints of boredom on a given job may result from suggestion, the conversations and remarks of the few bored workers on the job inducing other employees to develop the belief that the work is monotonous, although previously they had not thought it to be so. In one plant the word had passed among the employees that the work in one particular department was very monotonous. As a consequence, when persons were transferred to this department, they came to the job with a highly unfavorable attitude. In actual fact, after they had been on the job for some time, they found that the work was not so monotonous as they had been led to believe, and the conditions of work were far better than they had expected.

INCENTIVES AND MONOTONY

Method of Payment.—If monotony is the result of the conflict of motives, as has been suggested, then it follows that changing the condition of incentives in the working situation should produce changes in the amount of monotony. The two drives involved are the desire to stop the activity that, in and of itself, is uninteresting and the desire to continue it in order to achieve somewhat distant rewards in the form of wages, promotion, etc. Insofar as the more distant goal is concerned it would seem that, by either making it more desirable, as by means of a bonus, or making its consummation less distant by payment of wages daily instead of weekly or monthly, monotony would be reduced. In regard to the task itself, making the worker's attitude toward the work a more favorable one should also reduce monotony.

The only study that may be said to have approached the problem in terms of distant goals is one by Wyatt, Fraser, and Stock.[37] In their investigation girls engaged in repetitive work were paid a fixed weekly wage for 9 weeks, then for 15 weeks a competitive bonus system was introduced, and after this a form of piece-rate payment was put into force. During the time-rate period, monotony was at its highest, and, although the bonus system produced an increase in output, it led to rivalry and conflict among the workers. The piece-rate system proved to be the most satisfactory in all respects. A reversion to the time-rate system of payment broke down the gains previously recorded. The results of this investigation are inconclusive relative to the effects of increasing the desirability of the goal. The use of the piece-rate system of payment does not reveal any information about the effects of bringing the goal closer, since the payment was probably made weekly. Rather it seems likely that this system should be interpreted as developing a new attitude toward the work on the part of the employees. The completion of an item of work means completion for the worker himself and not completion for a vague, impersonal organization. Although it is unlikely that every time the worker finishes an item of work he "hears" the pleasant tinkle of another coin in his pocket, there can be no doubt that his orientation toward the work is different under the piece-rate system, since a new goal is now achieved with every item completed.

Organization of Goals.—If this analysis of the effectiveness of the piece-rate system is correct, it would follow that incentives other than financial ones should be effective in reducing monotony so long as they provide a series of goals, each of which is associated with the completion of an item or a series of items of work. According to Wyatt, Fraser, and Stock, it is the constancy of the flow of material that the worker is forced to handle that gives him the impression of an endless task.[38] If the material is supplied in batches, then the worker is given a task to do that can be completed, a task that is a self-contained unit. Under such conditions the worker gets somewhat the same satisfaction from the task as he does when he first attacks it at the beginning of the working day. The fact that there may be some adaptation to a monotonous task, so that one that initially seems boring may later prove acceptable and even interesting, indicates that the employee may spontaneously develop a changed attitude toward the work, and this changing of attitude is likely to include modification in motivational factors.[39]

SUMMARY OF METHODS FOR PREVENTING OR REDUCING MONOTONY

From the discussion of monotony in this chapter it is clear that much work remains to be done, particularly in the areas of the measurement of the extent and the effects of monotony. As industrial work becomes more and more routinized and simplified these problems will assume greater importance. We have seen that much is known concerning the conditions leading to monotony. The information collected to date furnishes evidence of the validity of the five following principles suggested some years ago by Wyatt, Fraser, and Stock for preventing or reducing monotony:[40]

1. Change the form of the activity at suitable intervals within the work spell.
2. Introduce rest pauses.
3. Arrange the workers into social groups rather than have them work in isolation.
4. Pay the workers on a piece-rate rather than a time-rate basis.
5. Attempt to foster the conception of work as a series of self-contained tasks rather than an apparently endless activity.

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CHAPTER XVI

WORKER MOTIVATION AND MORALE

The previous chapters dealing with procedures and conditions affecting industrial work may have conveyed the impression that the determinants of human behavior are simple. Such is far from the truth; rather, behavior is very complexly determined. The determinants are not related in a simple summative manner. The interplay among a common group of factors is such that in different situations different factors play the dominant role. Under one set of circumstances a given condition might result in changes of one kind, whereas under other circumstances the results might be quite different. The interactions among motives, conditions of work, and various aspects of the social milieu are far more important in the determination of human behavior in the industrial situation than any single motivating, environmental, or social condition. The difficulties encountered when attempting to explain or predict the behavior of workers may be illustrated by the following two examples.

A group of employees was engaged in work involving considerable eyestrain that experimental tests had indicated could be reduced by blue-green lighting.[1] When this type of light was introduced in the actual working situation the output of the men workers increased, and complaints of tiredness were reduced. With the women, on the other hand, output fell off, and complaints, dissatisfaction, and absences increased. When the cause of this unexpected reaction on the part of the women was investigated, it was found that they felt that the new type of lighting made them look "simply ghastly." The introduction of an apparently favorable condition of work therefore may not necessarily achieve the desired ends if it brings opposing or antagonistic motives into play.

Fairchild studied men engaged in various metal trades in four factories.[2] The work in factory A required the least amount of skill, that in factory B more, that in factory C still more, and that in factory D the most. Interviews with the workers in these factories indicated that in factory A the major source of satisfaction to the workers was the wages they earned. The conditions of work and the job itself contributed very little. In factory B the conditions of work supplemented by wages were the chief sources of satisfaction. The job itself and conditions of work were equally important sources of satisfaction at factory C, and at factory D the job itself was the outstanding source. These findings indicate that where skill is outstanding it is an important source of satisfaction to the workers and tends to depress the importance of wages and conditions of work. On the other hand, when the skill required is of a low order it becomes unimportant, and wages and conditions of work increase in importance as sources of satisfaction. Thus, although skill, conditions of work, and wages may each operate to produce satisfaction in the workman, when operating in conjunction their effects are not simply added together but rather are functionally dependent upon the interrelationships among these factors.

THE EFFECT OF EMPLOYEES' ATTITUDES UPON THEIR BEHAVIOR IN THE WORKING SITUATION

Attitudes Developed in the Working Situation.—That the employees' attitudes toward management and the working situation, and their beliefs as to what constitutes company policy, influence their productivity and behavior in the working situation cannot be denied. Perhaps the most striking demonstration of this is the famous "Hawthorne experiment" carried out at the Hawthorne plant of the Western Electric Company.[3] The investigation grew out of the failure to find the expected drop in output of a group of workers, when they were subjected to decreased intensity of illumination. The change in illumination apparently brought about a change in the attitudes of the workers, so that the deficient working conditions were compensated for by an increase in effort. From these findings the investigators realized that only by means of a prolonged research program could results be obtained that would clarify the causal conditions. Consequently six girls who assembled relays were placed in a segregated experimental room, called the *test room*, for a period of over two years and were subjected to a variety of standardized conditions. The conditions of work to which they were exposed are recorded in Table 109. As shown in the table, from the beginning to the end of the experimental period the girls showed a steady increase in production.[4] Even in periods when output might have been expected to drop, increases were manifest.

During the period of the investigation there was an increase in contentment among the girls, a greater interest in the job and in the

Table 109.—Working Conditions and Relative Productivity of Girls Engaged in Relay Assembly in the Hawthorne Experiment

Experimental period	Duration, weeks	Working days per week	Daily working hours	Rest periods	Scheduled rest pauses, total min.	Special features	Relative output per week
1	2	5½	8¾	0	0	Regular department	100
2	5	5½	8¾	0	0	Test room	101
3	8	5½	8¾	0	0	Group rate pay	105
4	5	5½	8¾	2	10	Two 5-min. rests	109
5	4	5½	8¾	2	20	Two 10-min. rests	112
6	4	5½	8¾	6	30	Six 5-min. rests	113
7	11	5½	8¾	2	25	Rests 15 min., A.M., 10 min., P.M.	116
8	7	5½	8¼	2	25	4:30 stop	123
9	4	5½	7¾	2	25	4:00 stop	125
10	12	5½	8¾	2	25	Check period	124
11	9	5	8¾	2	25	Saturday morning off	123
12	12	5½	8¾	0	0	No rests	122
13	31	5½	8¾	2	25	Rests	131
14	9	5	8¾	2	25	Saturday morning off	133
15	31	5½	8¾	2	25	Rests	135
16	4	5½	8¾	2	25	Operators changed positions	136
17	25	5	8	2	25	4:15 stop and Saturday morning off	138
18	15	4½	8	2	25	4:15 stop, Friday afternoon and Saturday morning off	140
19	15	4½	8	2	25	Operators returned to original positions	138
20	25	5	8	2	25	4:15 stop, Saturday morning off	138
21	. .	4	8	2	25	4:15 stop, Monday and Saturday morning off	138

working situation, and a reduction in absences of about 80 per cent. On the basis of repeated interviews and observation of the girls, the investigators were led to conclude that the increase in output was due to a change in attitude. Before any changes in the working situation were made the girls were consulted, their opinions as to the effects of the changes were solicited, and they worked under conditions free from hard and fast supervision. It appeared that the workers developed a new social orientation that was the major determinant of their behavior in the industrial situation, a new attitude that was not adversely affected by the experimental changes introduced.

Attitudes Developed outside the Working Situation.—If the employee's attitudes and feelings growing out of the working situation affect his behavior on the job, it is not unreasonable to suppose that attitudes developed from his home life and outside activities may also have important effects. Hersey intensively studied a small group of workers engaged in different occupations.[5] When they were in a positive and happy mood, their output was increased by some 2 per cent, and when they were disturbed it was reduced by 7 per cent. In a study of employees in a British cocoa works, reported by Hall and Locke, the home life was found to have very important effects.[6] The workers did not divide their life into two watertight compartments, one inside the factory and the other outside of it. The two were closely bound together, so that the troubles and joys of home life could not be put aside when reporting for work in the morning, nor could factory matters be dropped when returning home after work. An unsatisfactory home life was reflected in reduced effectiveness on the job.

GENERAL MOTIVATING FACTORS

In most cases it is impossible to subject motivation to the same type of controlled experimental investigation as can be done with such factors as methods and conditions of work. As has been pointed out, the determinants of behavior are so complexly related that it is difficult to keep all but one factor constant when studying its effects. Nevertheless it is important, regardless of the method used, to attempt to discover some of the general influences that are operating.

In the absence of a controlled experimental attack on these problems, investigators have devised and utilized various forms of the questionnaire, rating, and interviewing techniques. They have further analysed the statements of workers as these have appeared in various publications and as they have been obtained firsthand by investigators living among workers and participating in their industrial activities.

In certain instances the resulting studies are impressionistic rather than exact, but nevertheless they serve to point up the important factors in need of systematic scrutiny. These factors can be discovered by studying the stated aims of the worker, the fears that he manifests, the problems in which he expresses interest, and the reasons for which he leaves his job. Besides giving an over-all picture of the determinants of behavior relative to the working situation, such an approach should be valuable in setting up criteria by means of which the effectiveness of methods and conditions of work can be gauged.

Stated Aims of Employees.—Strong determined the aims of workers by noting down their desires as they have been reported in various publications.[7] He lists the following aims:

1. Steady employment, no discharge without cause, seniority
2. Job requirements: clear instructions, definite allocation of responsibility, freedom to do job in own way, being consulted about changes in job, good equipment and materials
3. Working conditions: protection against accidents and illness, proper heating, lighting, ventilation, sanitation
4. Wages: equitable, higher, sufficient to provide for comfort, proper differential according to skill
5. Hours of labor: shorter, vacation
6. Escape from fatigue, strain, exhaustion, monotony
7. Treatment as an individual, respect for opinions, voice in control of welfare conditions, individual freedom, freedom to consult and make suggestions, confidence of superiors
8. Enjoyment of work: knowledge of results and larger affairs of business
9. Voice and free will in determining work conditions, sense of responsibility
10. Grievances satisfactorily adjusted
11. Opportunity to rise on merits
12. Decent boss, real leader, fairness not sympathy
13. Approval of fellows and public, prestige
14. Recreational facilities, leisure
15. Savings, ownership of home
16. Insurance against risks of life as in accidents, sickness, old age, death
17. Abundant life, more education for self and children, best existence and happiness for family

Strong does not pretend that the above is a complete list of workers' motives, but simply offers it to give some notion as to the important aims. One difficulty with presenting such lists is that the reader will attempt to simplify the classification. Thus one might easily say that all the items in Strong's list may be summarized in the words "economic and personal security." Although this may be true, such a boiling-down process will obscure two major characteristics of the determinants of workers' behavior, viz., their variety and their specificity. The ultimate purpose for gaining a knowledge of workers' aims is to manipulate and control working conditions in order to effect the maximum adjustment of the individual worker. The worker is affected by specific determining conditions, and these specific determinants are never the same for any two individuals. Therefore in the practical situation of worker adjustment it is necessary to avoid generalizations of the reasons why people work.

Another method of getting at the general determinants of workers' behavior is the questionnaire method. A number of such studies have been made, of which two may be mentioned. Hersey presented groups of employees with fourteen items relating to the working situation and asked them to check the four most important ones and the four least important ones.[8] The results, shown in Table 110, indicate that steady employment, fair adjustment of grievances, amount of pay, working conditions, and safety are important problems to the employees, whereas a voice or share in the management, employee stock subscription, medical and dental care, and methods of pay are relatively unimportant.

TABLE 110.—IMPORTANT AND UNIMPORTANT ITEMS IN THE WORKING SITUATION AS INDICATED BY WORKERS' RESPONSES ON A QUESTIONNAIRE

Aspect of working situation	Important		Unimportant	
	Union	Nonunion	Union	Nonunion
	Per cent			
Steady employment	65	93	3	10
Fair adjustment of grievances	80	24	6	27
Amount of pay	49	51	0	3
Working conditions	49	45	3	3
Safety	57	21	6	7
Chance for promotion	28	47	13	7
Type of man in charge	18	38	28	34
Insurance system and pensions	18	36	16	10
Hours of work	13	23	3	21
Voice or share in management	13	6	78	69
Chance to show initiative	5	6	47	34
Employee stock subscription	5	2	100	93
Medical and dental service	0	6	72	17
Methods of pay	0	2	25	65

Chant had 100 young men employed in a department store and 150 engaged in other occupations rank twelve items relative to their work.[9] The relative importance of these factors as indicated by the responses of the men is practically the same for the two groups (see Table 111). It will be seen that opportunity for advancement, steady work, and an opportunity to use own ideas rank high, while good hours, clean work, and easy work rank low.

Certain discrepancies will be noted in the two investigations described above. In Chant's study, for example, advancement or promotion ranked high, whereas in Hersey's study very few union men and only half of the nonunion men checked it as being important. Similarly, whereas Hersey found that a large proportion of union men considered adjustment of grievances as being important, relatively few nonunion men did so. The causes of these differences are many. In part they may be ascribed to the research methods employed. Type of job would seem to be another important factor. Age and sex also probably play a part. The fact of individual differences should be noted.

TABLE 111.—THE RANKING OF ITEMS RELATED TO THE WORKING SITUATION AS GIVEN BY YOUNG MEN EMPLOYED IN DEPARTMENT STORES AND IN OTHER OCCUPATIONS

Aspect of working situation	Department-store workers	Workers in other occupations
Opportunity for advancement	1	1
Steady work	2	2
Opportunity to use own ideas	3	3
Opportunity to learn a job	4	3
Good boss	5	5
High pay	6	7
Opportunity to be of public service	7	5
Good working conditions	8	8
Comfortable working conditions	9	9
Good hours	10	11
Clean work	11	10
Easy work	12	12

Examination of Hersey's results in Table 110 will indicate only a few cases of perfect agreement between the two classes of workers. The wide variation that may exist among workers in their evaluation of factors relative to the job may be illustrated by an investigation of Wyatt and Langdon.[10] They had 325 women factory workers rank 10 items according to importance. The percentages of workers assigning the various ranks to the item of opportunity for promotion are shown in Table 112. It will be noted that the item appears at every rank, indicating considerable disagreement among the workers as to its relative importance. Furthermore there is no one rank in which the item receives a distinctively larger proportion so that it is impossible to assign to it a single value that will indicate its importance as compared with the other nine items.

TABLE 112.—THE PERCENTAGES OF WORKERS ASSIGNING VARIOUS RANKS TO THE ITEM "OPPORTUNITY FOR PROMOTION" WHEN COMPARING IT IN IMPORTANCE WITH NINE OTHER ITEMS

Rank	1	2	3	4	5	6	7	8	9	10
Workers, per cent	6.8	8.7	9.6	16.4	13.9	12.4	13.0	11.5	5.6	2.2

The same factor may be of utmost importance for some workers and of very little importance for others. Individual differences in motivation and the relative strengths of different motives are as great as individual differences in abilities, proficiencies, and personality traits. For two workers employed on the same type of job and with the same family and financial obligations one might be motivated relative to his job because of the financial returns it provides, and the other for the opportunity to work at tasks that are interesting to him.

Workers' Fears.—Uhrbrock has suggested that the worker is motivated by three major fears, viz., fear of losing his job, fear of loss of power to earn resulting from sickness or accident, and fear of an impoverished old age.[11] Kornhauser and Sharp found that, on a list of worries presented in a questionnaire, most factory workers checked the item fear of loss of job, and on a list of dislikes most of them checked the item possibility of layoff.[12] The importance of these fears in factory workers has also been confirmed through interviews with workers by Hall and Locke.[13] However, they found in addition that fears of novelty, ridicule, and disapproval are considered important by workers. The study of employees' fears would seem to be a fruitful source of information relative to the determinants of behavior. Unfortunately most of the interest appears to have been centered around fears based on economic considerations. Hall and Locke's study indicates that an investigation of fears arising out of the social situation would be fruitful.

Items in Which the Worker Expresses Interest.—In a plant of the Western Electric Company a system was introduced whereby the employees were interviewed relative to their work and their personal problems.[14] Cooperation was ensured since the employees were aware that their statements would be held confidential. The comments, both favorable and unfavorable, were classified according to the topic to which they referred. The following topics of interest to the employee were found:

Absence
Advancement
Aisles
Club for employees
Dirt
Fatigue
Floor
Furniture and fixtures
Hospital
Hours
Interest
Lighting
Lockers
Material
Monotony
Noise
Payment
Placement
Restaurant
Safety and health
Sanitation
Smoke and fumes
Social contact
Steady work
Temperature
Thrift
Tools and machines
Transportation
Vacation
Ventilation
Washroom
Welfare
Working space

It is important to note the wide variety of topics of such interest to the worker that he discussed them in the interview. It also is interesting to note that very few of the interests have to do with economic security.

Richards classified the topics mentioned by 243 factory workers in five interviews of the sort described above.[15] The proportion of workers mentioning each topic and the proportion of their remarks that involved grievances are shown in Table 113. The findings are similar to those observed in the study just cited. The coefficient of correlation between the proportion of workers mentioning the topics and the proportion of remarks that were grievances is -0.52. This means that the less important the topic is in terms of the number of workers mentioning it, the more likely their remarks about it will be unfavorable. This cannot be due to fear on the part of the workers to mention grievances, since 76 per cent of all remarks were grievances.

Reasons the Employee Gives for Leaving the Job.—When an employee voluntarily leaves a job, it means that he is not entirely satisfied with it. By means of an exit interview the reasons given by employees for leaving a job of their own accord can be systematically obtained and recorded. As Miller has pointed out, this type of information often discloses important determinants of behavior that otherwise would go unnoticed.[16] The results of one typical investigation by Ho, relative to department-store employees, are shown in Table 114.[17] Among other things he found that the reasons for leaving the job varied from department to department and varied with sex and with time of year.

TABLE 113.—THE PERCENTAGE OF FACTORY WORKERS MAKING REMARKS ABOUT VARIOUS TOPICS, AND THE PERCENTAGE OF THESE REMARKS THAT INVOLVE GRIEVANCES

Topic	Workers mentioning, per cent	Remarks that are grievances, per cent
Safety	37	57
Speed of work	17	93
Bonus	4	100
Wages:		
Rate	23	75
Distribution	6	100
Hours of work	18	91
Steadiness of work	8	68
Transfers and promotion	10	75
Supervision:		
Fairness and impartiality	18	34
Efficiency	11	62
General nature	42	45
Environment:		
Associates	12	83
Women in plant	6	86
Light, heat, ventilation	21	82
Cleanliness	9	95
Personnel and welfare activities	10	50
General plant procedure	25	82
Materials	7	100
Equipment	14	91
Attitude toward work	16	58

TABLE 114.—REASONS GIVEN BY WORKERS IN A DEPARTMENT STORE FOR LEAVING THEIR JOBS

	Per Cent
Reduction of force	31
Dissatisfaction with pay	16
Domestic reasons	12
Unsatisfactory work	8
Health	7
Others	26

FACTORS INFLUENCING THE ATTITUDES AND FEELINGS OF WORKERS

Estimates relative to the incidence of satisfied workers in the general employed population are in fairly close agreement.[18] It appears that a majority of workers, about two-thirds, are generally satisfied with their jobs. Although statistics such as these are useful in giving an over-all picture, they obscure certain important characteristics. Job satisfaction has many different points of reference, and few workers indeed are satisfied with all the aspects of their jobs.[19] The over-all measurement of job satisfaction may obscure differences in degree of satisfaction in specific areas, and compensatory adjustments that occur with variations in working conditions and other related factors. The satisfactions the worker derives from his job are not only many and varied, but are also highly subject to change. Interviews with workers have indicated that there is considerable variation in satisfaction from day to day and from week to week, and even hourly changes have been discovered.[20]

It has been suggested that the majority of discontented workers are temperamentally unsuited to their work and to their working situations.[21] Although it is true that the individual who manifests chronic emotional maladjustment is unlikely to adapt to any type of job, many persons characterized as maladjusted are disturbed only in rather specific areas. Remembering the many and varied requirements of the hundreds of different jobs that exist, it becomes apparent that what we are dealing with in this respect is a problem in the placement of the worker. Correct matching of worker characteristics and job requirements would remove most of the emotional and temperamental unsuitability causing worker dissatisfaction. In the present discussion we are concerned chiefly with the problems of the worker who has been at least reasonably well selected for his job in terms of abilities and personality traits.

Occupational Level.—It is ordinarily believed that individuals working in the higher occupational levels are more satisfied in their jobs than those in the lower levels. As one proceeds from unskilled jobs through skilled and office jobs to the professions, there is thought to be an increase in extent of satisfaction. Investigations of the relationship between occupational level and extent of satisfaction do not indicate this to be wholly true. Results obtained by Super suggest that as one considers the occupational scale from the lowest manual jobs, there is an increase in satisfaction up through the skilled occupations.[22] At this point a break occurs, so that with the lowest office occupations less satisfaction is again in evidence. From this level upward, increases in occupational level result in further increases in extent of satisfaction. This suggests that workers make a distinction in their minds between manual and nonmanual jobs, and that at the higher levels of each type more satisfaction is manifest than at the lower levels.

As one might expect, changes in occupational level—promotion and demotion—also affect job satisfaction. Super found that 67 per cent of individuals who had moved up in occupational level were satisfied, 65 per cent of those who had not changed level were satisfied, and 41 per cent of those who were reduced in level were satisfied. Related to the problem of promotion and demotion is that of the relationship between job satisfaction, on the one hand, and the difference between aspiration and achievement on the other. Super also found that, of those individuals whose jobs were exactly of the nature to which they aspired, 76 per cent were satisfied, whereas, of those individuals whose jobs did not measure up to what they aspired, only 34 per cent were satisfied.

Caste.—Not only are there variations in satisfaction with broad occupational groupings, but even within jobs that are roughly similar the worker makes a differentiation as to desirability. Although in part the ideas of differences between jobs are based on differences in wage payments, an equally powerful factor is the standing among his fellow workers that the job gives to the man, *i.e.*, his caste. Williams, who worked among men in factories, mines, and railroads in an attempt to get a firsthand picture of workers' motives has reported that there is a vast social gap between the individual who holds a "swell" job and one who holds a "bum" one.[23] For example, a laborer transferred to the millwright gang in one plant received an increase in pay of only 2 cents per hr., but the shift immediately changed his social status; he was congratulated by his fellow workers, and his wife and family were "received" where they were not before.

The causes of caste are many, and often obscure. Cleanliness of work is important, particularly among women workers.[24] If a man's work is connected with that of a laboratory technician, he may bask in reflected glory. Even among a group of employees carrying on exactly the same work and enjoying the same pay there may be observable differences in social status. Seniority, no doubt, plays a part. The position of the machine or desk at which the work is done and its relative newness or oldness may be important.

Within a given group, workmanship may set some individuals above others.[25] The worker who displays exceptional skill is looked up to by his fellows. As has been noted in interviews with men in metal trades, Fairchild found that workers derive considerable satisfaction from their skill.[26] Even workers engaged in such simple occupations as making boxes and tending machines may enjoy the work for its own sake.[27] It seems likely that this pride in work grows out of the worker's identification of himself with his job. As Williams puts it, workers have "a sense of ownership in a piece of property called their jobs."[28]

This personal identification with the job is manifest in a variety of ways. Railroad men refer to their engine as the "old girl" with no small amount of warmth and friendliness. Hall and Locke found that factory workers do the same sort of thing, christening their machines with such proper names as "Joey" and "Maggie."[29] Apparently, when given the chance, the workman will develop close associations with his job that manifest themselves not only in satisfaction but also in good workmanship. That such a spirit should arise is not surprising when one remembers, as McGregor and Knickerbocker have pointed out, that the workman spends almost as much time on his job as he does in active life at home.[30]

Age.—Age has been reported as related to job satisfaction and also as not related to it. Results obtained by Super indicate that the lack of agreement is due to the fact that satisfaction does not vary directly with age but rather shows cyclical changes with age.[31] His findings, shown in Table 115, indicate that individuals aged twenty-five to thirty-four and forty-five to fifty-four appear less satisfied than those at other ages.

TABLE 115.—THE RELATIONSHIP BETWEEN AGE AND JOB SATISFACTION

Age	Per Cent Satisfied
20–24	72
25–34	48
35–44	75
45–54	65
55–64	88

Financial Incentives.—The fact that methods of paying employees for their work vary so much makes their evaluation difficult. Much has been written concerning their good and bad aspects, but in most cases the arguments are based on rationalization rather than upon systematic investigation. Thus a bonus plan is said to be inadequate because good workers become discouraged when they see poor workers receiving an equal amount of money. Much work remains to be done in this field. A few typical results will be considered below.

A survey by the National Industrial Conference Board indicates that profit-sharing plans are very seldom put into force on the basis of employee's suggestions.[32] When such plans operate successfully, they appear to increase output, improve morale, and decrease labor turnover. In many cases, however, they do not work out satisfactorily. In analysing the reasons why profit-sharing plans were given up by various organizations, the Conference Board found that in about one-third of the cases unfavorable reaction on the part of the employees was reported, and, in another third, dissatisfaction on the part of the company. The remaining third gave no explanation or reported a variety of reasons. Workers' dissatisfaction with profit-sharing plans appears to stem from an understandable dislike of an irregular income.

Although payment on a piece-work basis brings about an increase in output and wages and a reduction in costs, it also results in a voluntary restriction in output.[33] Rightly or wrongly, most workers appear to feel that if their earnings are too high the rates will be cut, so that they will have to work harder and harder to earn the same amount of money. Through interviews with workers, Mathewson found that this voluntary restriction of output is far greater than is generally realized.[34] Besides restricting output in the belief that he is protecting his rate, the employee also does it to postpone layoff and to steady employment. It is brought about not only by the worker himself but also by pressure from other workers and sometimes even under orders from superiors. Grievances against the management, resentment against speed-ups, discouragement, and monotony quite naturally play a part, but in the main the stabilization of earnings appears to be the important consideration.

Supervision.—The conclusion drawn from the Hawthorne experiment, that the relationship between the employee and the management is more important in the productivity and happiness of the worker than any other factor, has been corroborated by other investigators.[35] As in the Hawthorne study, Kornhauser and Sharp found that working conditions were relatively unimportant as a factor in employees' attitudes.[36] In two departments in the same plant, in which the work was identical, only 29 per cent of the employees in the department with the better physical conditions of work had favorable attitudes, whereas in the other department 71 per cent of the workers had favorable attitudes. The unfavorable attitudes brought about by poor supervision spread to unrelated things. It is apparent therefore that a superficial examination of workers' complaints may give an erroneous picture.

McGregor and Knickerbocker have suggested that workers' objections to changes in the working situation are not so much due to the changes themselves as in the method of instigating them.[37] Since these changes affect the workmen they should be understood by them as being necessary and reasonable. This is just what occurred in the Hawthorne study. The workers never felt that a change would be made that would work against their welfare. As a consequence, even presumably unfavorable conditions did not reduce production, since the workers understood the experimental nature of the program and its ultimate objectives.

The evidence therefore clearly indicates that proper worker morale is to be built up by improving employer-employee relationships, so that the worker will be led to believe that his problems will be given due consideration and that he is an important part of the organization. Obviously such morale can only be developed if the worker has some feeling of security in his job.

PSYCHOLOGICAL APPROACHES TO PROBLEMS IN WORKER-MANAGEMENT RELATIONS

The foregoing discussion has shown the importance of morale as a factor in the productivity of workers. Improvement in the attitudes of workers brings about far greater gains than can be obtained by improving working conditions. Higher levels of productivity will result from increasing the motivation of the worker than from providing him with a superior method of work. However, as was pointed out in an earlier discussion of the nature and definition of effective work, productivity alone is too narrow a standard. High worker morale and the emotional adjustment it entails are important goals in and of themselves. The individual who is satisfied and adjusted with respect to his working situation is likely to be one who is well adjusted in his family, social, and community life. From the psychological point of view it therefore becomes important to discover the sources of discontent among workers and to consider means for overcoming the factors leading to maladjustment.

In order to present an integrated picture of the psychological problems arising from a consideration of worker-management relations and to see how they develop naturally, we shall follow the history of the Harvard-Westinghouse program that developed out of the original "experiment" at the Hawthorne plant of the Western Electric Company. We have already summarized the procedures and results of this investigation and have seen the positive evidence it offers relative to the powerful influence of worker morale and motivation. The setting and course of the "Hawthorne experiment," together with its subsequent developments, have been described in detail by Roethlisberger and Dickson in their now classic book, "Management and the

Worker." A recapitulation of the work of the Harvard and Western Electric Company investigators can well serve as a framework for presenting a description of important psychological approaches to worker-management relations.[38]

Implications of the Original "Hawthorne Experiment."—We have seen that the production of the girls engaged in the assembly operation in the test room increased regardless of specific changes in the conditions of work. Associated with this increased productivity were other somewhat less tangible improvements. There appeared to be a greater zest for work, more friendly interpersonal relations among the workers themselves, and significantly, an improved attitude toward management. The girls lost much of their fear of authority and took the view that management was directly interested in their welfare. Production regardless of costs to the worker was not management's aim. Rather management and workers cooperatively arranged conditions for the mutual benefit of both parties.

The crux of the matter was to discover the particular circumstances that brought about the gains. Since working conditions were not the determining factors, the benefits necessarily must have resulted from changes in the workers' attitudes toward management through supervisory control. At the beginning the girls operated under the joint supervision of their original departmental foreman and an investigator who was stationed in the test room. Gradually the supervision passed from the foreman to the investigator. The important fact is that the nature of the supervision given by the investigator differed markedly from that of the foreman. In order to maintain the "standard" conditions of the "experiment" the investigator went to great lengths to keep the girls happy and contented, so that their cooperation would be ensured. For example, whereas the foreman corrected a condition of excess talking by calling the girls to his office and reprimanding them, when the condition arose again the investigator talked the matter over with the girls and considered the problem with them in the light of the total working situation. This gave him occasion to deal with other matters brought up by the workers, and many problems were solved in addition to the original one of excessive talking. Inadvertently therefore in attempting to maintain standard experimental conditions the total social situation in regard to supervision was changed.

From this analysis it became apparent that a new orientation was needed in worker-management relations. Problems believed to be important by workers, and their desires and opinions, had to be given consideration.

Implications of Supervisory Conferences.—The Western Electric Company at this time was conducting training courses for supervisors by means of the conference method. One of the topics brought up for discussion was the problem of worker morale, the importance of which was now established from the results obtained in the experiment. It soon became apparent that among the supervisors there were varied and conflicting opinions concerning the causes of low worker morale and methods of improving it. The essential facts were lacking, and it was obvious that the supervisors themselves were unable to supply them.

The Origin and Nature of the Worker-interviewing Program.—From the two separate sources, the results of the test room and the supervisory conferences, arguments led directly to the need for a program for interviewing workers. The test-room results pointed to the intimate relationship between supervision and morale and at the same time indicated that ordinary supervisory procedures were not wholly adequate. The confusion concerning causes of low worker morale, which was found in the supervisory conferences, indicated a need to obtain information directly from the workers. Putting the two together it became apparent that a system of interviewing workers would provide direct information concerning factors in morale and at the same time might improve morale by developing more satisfactory worker attitudes toward management, as was accomplished in the test room.

As a consequence a plan for the interviewing of workers was devised. The findings were to be used in two ways: first, pertinent data would be passed on to those departments responsible for plant conditions, and, secondly, the findings would furnish material for use in the training programs for supervisors. In order to administer the program the interviewers were assigned and made responsible to a special Industrial Relations Division. This was necessary in order to provide an integrated program with uniform purposes and procedures, a plan for proper training and supervision of the interviewers, and a means for expediting the collation and transmission of findings.

Each interviewer was assigned several hundred workers whom he interviewed at repeated intervals. It was the task of the interviewer to obtain immediate cooperation of the operational supervisors and foremen. He would go to a department and indicate which worker he desired to see and in most cases would be formally introduced to the worker by the foreman. Generally the interview would take place away from the workbench at some empty desk or near-by room. The interviewer began by explaining the purposes of the program to the worker. The interviews were made on a highly personal basis, and anonymity was guaranteed. All conversations were considered confidential, and, although the interviewer took extensive notes, he reported his findings to the Research Division without mentioning names. It is obvious that this was a necessary precaution in order to reassure the workers that their complaints would not be held against them.

That the workers were sold on the value of the program and its confidential nature is indicated by the fact that during the second year of the interviewing program, when the program itself was mentioned by workers in interviews, some 80 per cent gave favorable reactions. Since in the interviews approximately half of the workers' comments were unfavorable, it seems likely that the workers were generally unafraid of possible adverse consequences to themselves. Indeed in their reactions relative to supervision some 60 per cent of their comments were unfavorable.

Development and Outcome of the Worker-interviewing Program. Although the interviews were not conducted in a highly standardized manner, with set questions requiring yes-no answers, the interviewers nevertheless had definite questions in mind and systematically attempted to explore certain areas, such as supervision and working conditions. The tendency was for the interviewer to lead the conversation and for the worker to follow. It was found, however, that this procedure was difficult to adhere to in many cases. The worker would start talking about the suggested topic but would soon wander off to another subject. In spite of the interviewer's attempts to bring him back to the original topic, the worker would again wander off to the subject that interested him. In such instances there was obviously some one problem uppermost in the worker's mind. In other cases the conversation of the worker would merely wander to supposedly "irrelevant" topics, such as his experiences and his personal life. Some workers were found to be generally reticent but would become most communicative if just the right topic was brought up.

This situation led to the adoption of a new approach in the interviewing of the second year of the program. The worker now was allowed to talk spontaneously, and the interviewer did not interrupt or change the subject to one he thought more important. When this nondirected technique was used the length of the interview increased from about ½ to 1½ hr.

As further experience was gained it became more and more apparent that the remarks of the workers did not provide quite the concrete material concerning plant conditions that had been anticipated. To be sure some valuable information was gained concerning the workers' points of view on various topics and matters that they considered important. However, the remarks of the workers were in many cases too vague to be of great use. Complaints were made about certain conditions, such as sanitation, which actually were wholly adequate. A number of conditions mentioned by the workers were well known to the management and would have been ascertained without recourse to a program of interviewing workers.

In certain of the workers' criticisms, particularly those about company policy and about persons, it was most difficult to locate the point of reference and hence apply remedial procedures. Therefore management's point of view was that although the program was helpful and desirable in many respects, the information it provided was by no means wholly reliable or useful.

It has been noted that in the interviews the workers strayed from the set topics, and were most fluent in regard to those topics that had a strong personal reference for them. This, together with the certain unreliability of their comments, indicated the need for a closer analysis of the nature of their complaints. From one point of view verification of workers' complaints is irrelevant; they refer not to plant conditions as they exist but rather to the way they appear to the worker. Thus a complaint may not necessarily have its source in some actual working condition but may lie in the hopes, fears, feelings, and motivations of the worker. A complaint therefore should be considered not only with reference to the object of the complaint but also in relation to the personal situation of the worker.

Some examples will clarify this point. A worker might be complaining about her foreman. To the interviewer she may be able to cite specific and apparently justifiable instances of poor supervision. However, the whole source of the trouble might lie in the fact that the foreman reminds her of her stepfather whom she resents and dislikes. Under other circumstances the particular behavior of the foreman now complained about would pass unnoticed, and the resolution of the immediate situation lies not in a revision of the relationship between the worker and the foreman but rather in the adjustment of the personal problems of the worker. Similarly a worker who complains about rates for piecework might be worried about a temporary financial burden, occasioned through illness in his family, and not be concerned with the unfairness of the pay rates. The basis of a worker's complaints about working conditions might not be an actual inadequacy of such conditions as illumination and ventilation but rather frustrated ambitions for advancement.

It is clear therefore that the manifest content of workers' complaints cannot be taken wholly at face value, and in addition the latent content must also be determined. Thus it became apparent to the investigators at the Western Electric Company that certain complaints, at least, could not be treated as facts in and of themselves but had to be considered as signs of personal or social problems that needed resolution.

The Origin and Nature of the Personal-counseling Program.—Just as the impetus for the worker-interviewing program came from several different sources, so the various worker adjustment situations that came to light in the interviewing program led to the establishment of a program of personal counseling. A point made earlier in this chapter in another connection, and again demonstrated in the interviewing program, is that the sources of low morale are many; some are job-connected and some are not, but all are woven together in the complex of the worker's emotional adjustment. Resolutions of maladjustments, even though appearing minor, assumed a greater role in the thinking of the Western Electric Company investigators. The keen interest of the workers in problems that to them had a personal reference, and the revealing nature of the latent content of complaints, pointed the way. The importance of the personal aspects of the situations talked about and the value of the relief from psychic tensions that followed the personal conference are testified to by the numerous workers who, after stating their problems and complaints in the interview, said with great relief, "It's good to get it off my chest."

It was the purpose of the personal-counseling program to seek resolutions of unsatisfactory mental conditions of the worker. In general the same procedure was employed as was used in the interviewing program. Each interviewer was assigned several hundred workers as his "territory," and the arrangements were made and the interviews conducted as in the previous program, the nondirected interviewing technique being used. It is beyond the scope of the present discussion to consider the details and techniques of psychotherapy, though such matters obviously must be understood if a complete analysis of the situation is to be effected. However, two matters do need consideration, the manner in which the difficulty is resolved and the responsibility for the resolution.

In the counseling interview the interviewer in employing the nondirected technique does not lead the interview. He provides the stimulus for the initiation of the conversation and leads it only in the sense that he tries to get the counselee himself to bring out pertinent and important matters. In the resolution of a difficulty the first step is to provide a clear description of the problem. The interviewer never attempts to state the problem directly, but rather, by indirect methods, he seeks to have the counselee do so. In many instances the solution is immediately apparent to the counselee once the problem is clear to him, and the tension is thereby relieved. In other instances, where the solution is not so easily reached, the interviewer again resorts to indirect methods to bring the counselee around to discover and state the most likely solutions.

Both in the clarification of the issues and in the development of the solutions, although the interviewer may immediately see the problem and the means for its resolution, he does not directly suggest them to the counselee. He uses such knowledge only to direct the thinking of the counselee, so that he is able to discover them for himself. Solutions arrived at in this manner appear to be more adequate and more satisfying to the individual than those given to him directly through the authority of the counselor. They are more likely to be accepted, and therefore result in more consequential action. In addition to this more satisfactory manner of resolving the difficulty, it puts the responsibility for the solution on the individual himself and not on the counselor. Clinically this appears to be highly desirable.

In addition the question may well be raised as to whether an employer can justifiably dictate to those he employs the ways in which they should act with reference to matters that are of a highly personal nature to them. To do so would be going beyond any conceivable moral obligation of management. However, it is within the employer's realm to provide the means by which the worker can arrive at his own solutions.

Although it is true that the kind of employee interviewing being considered here requires that the comments of the workers be held confidential, a very special relationship exists between the interviewer and the interviewee when personal problems are being dealt with, as in the counseling program. It is the sort of relationship that exists between the doctor and his patient, or the lawyer and his client. The interview records are the confidential property of the counselee and of the counselor and can be revealed in part or in whole only with the consent of both parties, and then only after careful consideration and under certain circumstances. Obviously, therefore, any information obtained by the counselor from the persons being interviewed can at best be passed on only in very general form, if at all. Thus the counseling is an end in and of itself. The interviewing program, however, in addition to offering some solution to the worker's problem, yields data that can be used as a basis of action for nonindividual problems arising in the industrial situation.

It is important to note the difference in aims between the two programs. The interviewing program was set up chiefly for the purpose of fact finding. Actually it also relieved some tensions simply by providing an opportunity for the worker to "talk things over" with a sympathetic person. On the other hand the purpose of the counseling program was to uncover and relieve the conflicts of the individual worker and thus indirectly, through improvement of morale, to increase the effectiveness of the work of the organization.

Comparison of the Worker-interviewing and Counseling Programs. The foregoing description of the history of the interviewing and counseling programs at the Western Electric Company was not given to describe the experience of one industrial organization, but rather to illustrate the two major types of psychological approaches that have been made to the solution of problems in worker-management relations. Clearly a large proportion of the problems are economic, and others are of a sociological, psychological, and medical nature. We are here concerned only with those matters falling within the province of the psychologist.

There are many variations of the two programs just described, which have employed different techniques and had somewhat different aims. Nevertheless they essentially resolve themselves into (1) those programs attempting to improve morale indirectly by ascertaining the industrial problems in which the workers are interested and by listening to their complaints, and then changing plant conditions and improving supervision; and (2) those programs attempting directly to improve morale by solving the personal problems of the workers and thus directly relieving the worker's psychological tensions. Obviously the two modes of approach are not wholly mutually exclusive, but for purposes of evaluation they can be considered separately.

Both approaches have the desirable feature of providing the individual worker with an opportunity for expressing himself on matters he considers important. However, as far as complaints relative to environmental and social conditions in the organization are concerned, only the interviewing program provides a channel to top management so that corrective action can be taken. On the other hand, although the interviewing program does help to some extent in increasing the emotional adjustment of the individual through removal of tensions, it can at best reach only superficial problems, and a counseling program is needed in order to provide a means for getting at deep-seated problems and arriving at long-term solutions. To achieve this, however, the counseling program needs highly qualified professional personnel, which is not a requirement of the interviewing program.

Worker-interviewing Plans in Relation to Supervision.—A characteristic of the Western Electric Company interviewing program, and indeed of almost all similar plans, is the manner in which ordinary lines of authority are by-passed. Information is obtained from the worker not by his immediate supervisor but rather by personnel operating from an entirely separate jurisdiction. Furthermore the information does not pass through the usual supervisory hierarchy but goes directly to a section of top management.

This matter has generally received little attention, and the fact remains that the problems it might bring about have not been sufficiently explored. Ordinarily it is dismissed from consideration, because the reactions of supervisory personnel to worker-interviewing plans have not been too unfavorable, and because it is felt that the information obtained through special interviewers can be collated and distributed to appropriate departments with greater dispatch. Furthermore such a procedure tends to remove any fears on the part of the workers that their complaints will be held against them by their immediate supervisors and thus provides a means for uninhibited discourse.

From a completely objective analysis it would appear that the foregoing reasoning presupposes that supervision and supervisory channels must necessarily be inadequate. More specifically it may be said that the following assumptions are made: that (1), owing to the particular social situation existing between supervisors and workers, the latter cannot or will not approach the former with problems that have a highly personal reference; that (2), owing to the nature of the relationship between supervisors and those supervised, the latter cannot or will not bring up for discussion with the former unfavorable working conditions occurring in that relationship, and therefore resolution of such problems can only be obtained through a third party working in a roundabout manner; and that (3) information obtained from workers by lower supervisory personnel will be inadequate and will not be adequately passed up the line to higher levels.

It follows that, if these assumptions are true, the interviewing program is simply a device, which is added to the present organizational structure, to increase the morale and adjustment of workers and at best only strikes at the problem indirectly. In such a case management must be held at fault for inaccurate selection and training of supervisors. On the other hand, if the assumptions are false then the interviewing program assumes a much less important role. With good supervisor-worker relations, many interpersonal conflicts can be resolved immediately and at the level where they arise, if the supervisor has the appropriate talents and background to command the respect and confidence of the worker. There would then be no problems that the worker could not discuss with his supervisor, because the worker would be without fear of reprisal. The supervisor would have to be thoroughly trained to evaluate the information and determine what portions of it should be passed up for action at higher levels.

This does not mean that the interviewing program has no place whatsoever in an industrial organization. Certainly in initial attempts to improve morale among the workers it will be a most helpful implement in providing an immediate and acceptable procedure for workers' complaints to be heard, in that it provides factual material to be used in supervisory training and in the correction of inadequate plant conditions. But in later stages, with a sufficiently adequate and sympathetic supervisory system established, its role as a fact-finding procedure and escape valve for workers' emotions should be distinctly at a minimum or nonexistent.

To be sure, even under the best of conditions, human frailty and error will be manifest in a well-developed supervisory system. Continuance of a modified and somewhat restricted program of interviews with workers by an independent group furnishes a system of checks and balances needed in any social organization. Indeed, if for no other reason, being a function of top management, a system of employee interviewing might well be the means for keeping alive in the minds of top management the problems of personnel at lower levels in the organization. Regardless of its advantages the interviewing program does demand a split in supervisory authority and responsibility, and, unless the division is clear-cut and willingly accepted by supervisory personnel, the plan will not be wholly effective.

Worker-interviewing plans therefore are not, in and of themselves, the remedy for low morale. Unfortunately, in the discussion of various means of improving morale, it is the plans that have been publicized and not the aims. The aim should be clearly kept in mind—more effective work through better worker morale brought about by more understanding supervision. The key therefore is supervision, and indeed that is the lesson of the original Hawthorne experiment in the test room. In earlier chapters we have considered means for the selection and training of workers, including supervisory personnel, and ways for measuring their success. Without the proper basic human material for supervisory positions, and without continuous training of that material, satisfactory supervision cannot be achieved.

Worker-counseling Plans in Relation to Supervision.—The situation with regard to the personal counseling of workers in relation to supervision is very different from that of the fact-finding interview. In this area the need for a separate organization is readily apparent. The problems require personnel with a professional training and background that just is not to be found among supervisors. Insofar as the supervisors are concerned in this respect, they should have an understanding of the importance of the psychological adjustment of workers, and, to be sure, of themselves. They should be brought to a realization that personal counseling is not just for the trouble makers and the neurotics, but rather that all individuals have problems that need resolution, and that the resolution is likely to result in greater satisfaction, more effective work, and higher levels of production. The relationship between the supervisor and the personal-counseling organization will be similar to his relationship with the safety department, the training department, and the medical officer. These are activities that are coordinate with the operational departments and enclose the activities of specialists.

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